

SCIENCE

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FRIDAY, NOVEMBER 29, 1901.

CONTENTS:

<i>The Relation of Yale to Medicine:</i> PROFESSOR WILLIAM HENRY WELCH.....	825
<i>Varietal Mutation in the Tomato:</i> DR. C. A. WHITE.....	841
<i>Scientific Books:—</i>	
<i>Bather on Echinoderms:</i> PROFESSOR C. E. BEECHER. <i>Overton's Studien über die Narcose:</i> DR. S. J. MELTZER. <i>Thomas's Les matières colorantes naturelles:</i> PROFESSOR MARSTON TAYLOR BOGERT. <i>Pfeffer's Pflanzenphysiologie:</i> DR. D. T. MACDOUGAL.....	844
<i>Scientific Journals and Articles.....</i>	847
<i>Societies and Academies:—</i>	
<i>The American Physical Society:</i> PROFESSOR ERNEST MERRITT. <i>The Biological Society of Washington:</i> T. W. STANTON. <i>The Torrey Botanical Club:</i> PROFESSOR EDWARD S. BURGESS. <i>The Science Club of the University of Wisconsin:</i> L. S. SMITH. <i>The Scientific Association of the University of Missouri:</i> DR. CHARLES THOM. <i>The Academy of Science of St. Louis:</i> PROFESSOR WILLIAM TRELEASE....	848
<i>Discussion and Correspondence:—</i>	
<i>The Python in Pennsylvania:</i> E. L. MOSELEY..	852
<i>Shorter Articles:—</i>	
<i>The Unexplained Southerly Deviation of Falling Bodies:</i> PROFESSOR FLORIAN CAJORI. <i>Astigmatic Images of the Bottom of a Pool of Water:</i> PROFESSOR FRANCIS E. NIPHER.....	853
<i>Notes on Inorganic Chemistry:</i> J. L. H.....	855
<i>Current Notes on Physiography:—</i>	
<i>The River System of Connecticut; Lake Winnipeg; A Piedmont Lake in Bavaria:</i> W. M. DAVIS.....	856
<i>Thermodynamics of the Gas Engine:</i> PROFESSOR R. H. THURSTON.....	859
<i>The New Star in Perseus.....</i>	860
<i>The U. S. Naval Observatory.....</i>	861
<i>Scientific Notes and News.....</i>	861
<i>University and Educational News.....</i>	864

MS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE RELATION OF YALE TO MEDICINE.*

ON this fourth jubilee of Yale University, speaking, as I trust I may, in behalf of many hundreds of physicians who have received their liberal or professional education in this institution, I bring affectionate greetings to our alma mater, and offer our hearty congratulations on this happy anniversary. With all the sons of Yale we join in the prayer of President Stiles: 'Peace be within thy walls, O Yale, and prosperity within thy palaces.'

Yale is related to medicine most directly through her medical department, but also through all who have studied here and subsequently practiced the art or cultivated the science of medicine. The Medical School, although the first department added to the College, was not established until over a hundred years after the foundation of the Collegiate School at Saybrook. From the beginning, however, graduates of the College are to be found in the ranks of medical practitioners, and any account of the relation of Yale to medicine would be most incomplete without some consideration of the alumni of the eighteenth century who were physicians. Their history makes a large part of the medical history of Connecticut during that century, but it is not limited to this State.

* An address delivered October 21, 1901, at the two hundredth anniversary of the founding of Yale College.

EIGHTEENTH CENTURY.

Doubtless the student of universal medical history, who, after tracing the wonderful development of medicine in the century of Harvey, Malpighi and Sydenham, is engaged in following medical progress through the eighteenth century, marked by such names as those of Boerhaave, Haller, Morgagni and Hunter, would not turn aside long to note what the physicians of Connecticut or, indeed, of any part of America were doing at that time. Still the records of these early Yale physicians have the interest which attaches to the beginnings of things which have become important, and for us the special and sympathetic interest which belongs to the annals of family and country.

When the first physicians who had received their collegiate training at Yale appeared upon the scene early in the eighteenth century, the state of medicine in this country had not advanced materially beyond the primitive condition of the early colonial days. We encounter, as in the early history of medicine everywhere, three classes of medical practitioners: the priest-physician, the regular physician educated and practicing according to the recognized standards of the day, and the empiric or charlatan. What Cotton Mather called 'the angelical conjunction' of the cure of the soul and of the body was to be found most frequently and in its best type in New England. Here the regular training of physicians was almost wholly by apprenticeship for three or four years to some practitioner of repute. As vividly portrayed by a Connecticut physician, "The candidate 'served his time,' as it was then called, which was divided between the books on the shelf, the skeleton in the closet, the pestle and pill-slab in the back room, roaming the forests and fields for roots and herbs, and following, astride of the colt he was breaking, the horse which was honored with the saddlebags."

Nor was this condition very materially changed during the eighteenth century by the founding of the Medical Departments of the College of Philadelphia (now the University of Pennsylvania) and of King's College (now Columbia) in the decade before the Revolution and of those of Harvard in 1783 and of Dartmouth in 1797. During this century only two graduates of Yale College (John A. Graham, Y., 1768, and Winthrop Saltonstall, Y., 1793) had received a medical degree in course. The number of students from the New England colonies who resorted to the medical schools of Edinburgh, London or Leyden was extremely small, much smaller than that from the Middle and Southern colonies.

With the exception of a law passed in New York in 1760 and a similar one in New Jersey in 1772, there was no effective legislative control of medical practice in any of the colonies. Any one who chose could practice, and the root-doctors and Indian doctors of Connecticut had their counterparts elsewhere. More from the sparseness and poverty of the population than from the absence of disease, the remuneration from medical practice was so small that the physician often added some other occupation, most frequently agriculture, to the practice of his profession.

There were no hospitals, except pock-houses, and practically no medical organization. There was little opportunity for intercourse and interchange of views between physicians in different parts of the country, so that local peculiarities of practice were more common then than now. The only text-books were European, the most authoritative on medical practice being the works of Sydenham and of Boerhaave, later also of van Swieten, Mead, Huxham and Cullen. There was no American medical journal until near the end of the eighteenth century.

With two or three exceptions the few

original medical publications, mostly short pamphlets, by American physicians before the Revolution contained scarcely any personal observations of importance, so that the names of these physicians are remembered to-day by their reputation among their contemporaries and their influence upon their successors, rather than by any actual contributions to medical knowledge.

After this necessarily brief statement concerning some of the conditions of medical practice in the New England colonies, we are better prepared to appreciate the position and work of those graduates of Yale College in the eighteenth century who became physicians.

The course of studies at the College was planned rather for the preliminary training of ministers than of doctors, but it furnished a classical education, which was then more necessary for the study of medical books than it is to-day. There seems to have been at least some interest in the College in medical knowledge, if one may judge from the titles of some of the early theses and from the possession by the College of a human skeleton and 'paintings of the human body skin'd,' as they are inventoried. President Stiles occasionally delivered a lecture on medicine, and in his recently published 'Literary Diary' he gives an interesting outline of one of these lectures, the main headings being, I. Anatomy; II. Pathology; and III. The Methodus medendi (one of the sub-headings here being 'Efficacious medicines but few')—sufficiently comprehensive, it may be said, for a single lecture even in those days.

The success attained by the Yale physicians of the eighteenth century indicates that the College then, as ever since, supplied its graduates with a training of mind and character adapted to the circumstances of time and place, and fitting them for the work of life in any field.

Mainly by the aid of Professor Dexter's

invaluable two volumes of 'Biographical Sketches of the Graduates of Yale College,' covering the period from 1701 to 1763, and a kind personal communication relating to the remaining classes, I have been able to determine that there were at least 224 Yale graduates in course of the eighteenth century who practiced medicine. This figure, which is certainly somewhat below the correct one, is 9.7 per cent. of the entire number of Bachelors of Arts for the same period—a percentage about the same as the corresponding one for the nineteenth century.

Of the seven graduates in arts from the College in the first two decades of the eighteenth century who became medical practitioners, all, with one exception, were also clergymen, and of the seventy-two physicians graduated in arts in the first half of the century nearly one-fourth were clerical, whereas after this there are only a very few names of clerical physicians.

All who are familiar with the early colonial history of New England know what an interesting class the clerical physicians were. Not a few of them were educated, skilful physicians, who ranked among the leading practitioners and teachers of medicine in their day, while others were, on the medical side, scarcely more than 'comforters of the sick,' as they were sometimes called, rather than active practitioners. One of the earliest and most celebrated of this class of physicians was the Rev. Thomas Thacher (1620-1678), of Boston, the direct ancestor of our own honored and beloved Latin professor of the same name. His name is preserved in medical annals as that of the author of the first solely medical publication in America, a broadside folio which appeared in Boston in 1677, and is entitled: 'A brief rule to guide the common people of New England how to order themselves and theirs in the small pocks or measles.'

But of all those who combined the offices

of clergyman and physician, not one, from the foundation of the American colonies, attained so high distinction as a physician as Jared Eliot of the class of 1706, who was the first graduate of Yale College to enter upon the practice of medicine. His name is preceded in the triennial catalog by that of Phineas Fiske of the class of 1704, who was eminent both as a divine and as a physician, but whose shorter professional career did not begin until five or six years after that of Eliot.

The name of Jared Eliot is a worthy one to lead the long line of over 2,300 physicians who have received their liberal or professional education at Yale College. The grandson of the Rev. John Eliot, the Apostle to the Indians, he spent his long, twofold professional life of fifty-four years in the town of Killingworth (now Clinton) in this State, where he succeeded in the ministerial office his teacher, Abraham Pierson, the first rector of this College. Of fine bodily presence and engaging personality, for many years an influential trustee of Yale College, the library fund of which was started through his bequest, the friend and correspondent of Benjamin Franklin, Bishop (then Dean) Berkeley and other learned men, a fellow, it is said, of the Royal Society and recipient of a gold medal from the London Society of Arts, accounted in his day an excellent botanist, chemist and practical and scientific agriculturist, Eliot, as is stated by Dr. James Thacher in his *American Medical Biography* (1828), 'was unquestionably the first physician of his day in Connecticut,' and in chronic complaints "he appears to have been more extensively consulted than any other physician in New England, frequently visiting every county of Connecticut, and being often called in Boston and Newport." It is also said of him that "for forty successive years he never omitted preaching either at home or abroad on the Lord's day."

With evidences of such manifold activity one is prepared to accept the statement in his funeral sermon: "Perhaps no man slept so little in his day, and did so much in so great variety."

It is customary to speak of Jared Eliot as 'the father of regular medical practice in Connecticut,' and when one considers the number of physicians who were trained under him, and that among these were such leaders of the profession and successful teachers of medicine as his son-in-law and successor in practice, Benjamin Gale (Yale, 1733), and Dr. Jared Potter (Yale, 1760), the title seems justly conferred.

Among other clergymen noted in their day as medical practitioners may be mentioned Eliot's classmate, Jonathan Dickinson, the first president of Princeton College, whose paper published in 1740, entitled, 'Observations on that terrible disease, vulgarly called the throat distemper,' is the first medical publication by a graduate of Yale College, and the third on diphtheria by an American; Benjamin Doolittle, Yale, 1716, Northfield, Mass., 'well skilled in two important arts,' according to his epitaph; Timothy Collins, of the class of 1718, traditions of whose practice are still current in Litchfield County; Isaac Browne, of the class of 1729, an early member of the New Jersey Medical Society, the first State Society organized in this country; Moses Bartlett, 1730, the pupil and son-in-law of Phineas Fiske, described on his monument as 'a sound and faithful divine, a Physician of Soul and Body,' and the father of a son of the same name, graduated in 1763, who was one of the last of the clerical physicians; Dr. John Darbe, of the class of 1748, who received the honorary degree of M.D. from Dartmouth in 1782, and is the first graduate of Yale College to become doctor of medicine; and Manasseh Cutler (Yale, 1765), skilled in medicine as well as in many other arts.

The first non-clerical physician in the list of graduates is Jeremiah Miller of the class of 1709, who settled in New London. He seems, however, to have been more engrossed with other occupations than with medicine, so that Professor Dexter names John Griswold of the class of 1721, of Norwich, Conn., as 'the earliest graduate of the College who devoted himself exclusively to the profession of medicine.'

Among the two hundred and more eighteenth-century graduates of Yale whose principal or sole professional occupation was medicine are to be found the names of many physicians whose memories are preserved, and of whose useful lives and faithful service in their calling this College may justly be proud. Some were among the most influential and widely known medical men of their time and country. Such were Alexander Wolcott (1731), whose scholarly attainments in medicine are attested by the interesting collection of his books still preserved; Benjamin Gale (1733), one of the few pre-Revolutionary American physicians who have left published records of valuable medical observations; Leverett Hubbard (1744), corporator and first president both of the New Haven County Medical Society and of the Connecticut Medical Society, for many years the recognized head of the profession in this city and county; Eneas Munson (1753), successful, able and learned, one of the longest-lived and most remarkable physicians of his day, the first name in the medical faculty of the Yale Medical Institution; Jared Potter (1760), described by Dr. Bronson as 'the most celebrated and popular physician in this State' in the first decade of the nineteenth century; Mason Fitch Cogswell (1780), one of the 'Hartford wits,' before the arrival of Nathan Smith, the most distinguished surgeon in this State, whose name has a permanent place in the history of

surgery; Eli Todd (1787), the first superintendent of the Retreat for the Insane at Hartford, who is honored by humanitarians and physicians alike as 'the first in this country to introduce the more humane methods of care and treatment of the insane'; John Stearns (1789), professor of medical theory and practice in the College of Physicians and Surgeons, western district of New York, president of the New York State Medical Society, who has the credit of first calling the attention of the medical profession to the use of ergot in obstetrics, and Thomas Miner (1796), whose ingenious and erudite essays on fevers and other medical subjects, written partly in conjunction with Dr. Tully, attracted wide attention and much comment both in this country and in Europe. To those familiar with this period of American medical history, particularly in Connecticut, other names will occur which might with equal propriety be mentioned, did time permit.

Some who belonged to the medical profession are better known as holders of high public office, and for their services to their country, than as physicians. Of the five medical signers of the Declaration of Independence two were graduates of Yale, both in the class of 1747—Oliver Wolcott, Governor of Connecticut, who studied medicine with his brother Alexander, already mentioned, and practiced for a short time in Goshen, in this State, and Lyman Hall, the first Governor of the independent State of Georgia, where he followed his profession with marked success. Nathan Brownson, of the class of 1761, who was Governor of Georgia, a member of the Provincial Congress and of the Continental Congress, and the holder of other high public offices, was likewise a practicing physician and was appointed by Congress deputy purveyor of hospitals and later to the charge of the southern hospitals in the revolutionary war.

The importance of the services of Yale graduates as surgeons and surgeons' mates in the French and Indian war and the Revolutionary war is not to be measured only by the passing mention which I find it possible to give to them here. I have found the names of ten graduates who served in a surgical capacity in the former war, headed by the doughty clerical physician, Timothy Collins (1718), the first Yale army surgeon.

In 1776 the General Assembly of Connecticut appointed a committee of eighteen of the leading physicians of the State to examine candidates for the positions of surgeons and surgeons' mates in the Continental Army, and some idea of the standing of Yale graduates then in medical practice in Connecticut may be gained by the facts that this Committee was headed by Alexander Wolcott and contained ten graduates of the College.

The earliest Yale graduate who held a commission in the American Revolution was a physician, Joshua Babcock of the class of 1724, Major General of the Rhode Island militia. He had walked the hospitals in London in 1730, being the first graduate of the College to study medicine in Europe, and for nearly twenty-five years was an active practitioner in Rhode Island. Mr. Henry P. Johnston's book, 'Yale and Her Honor Roll in the American Revolution,' gives the records of twenty-three graduates who served as surgeons or surgeons' mates in this war, and of six other physicians who were officers in the army.

The first bestowal of the degree of Doctor of Medicine in America was by Yale College in 1723, when Dr. Daniel Turner, a well-known London physician and voluminous medical writer received the honorary degree. The first American medical degree in course was given by the College of Philadelphia, now the University of Pennsylvania, in 1768. The first graduate of Yale College to receive a medical degree in

course was John Augustus Graham of the class of 1768, who was graduated bachelor of medicine from Columbia in 1772, and the first to be admitted to the doctorate of medicine in course was Winthrop Saltonstall of the class of 1793, M.D. Columbia, 1796.

There are certain directions in which Yale graduates during the eighteenth century especially contributed to the improvement of medical conditions in this country, an improvement everywhere slow and well marked only after the Revolution.

The Yale physicians of the eighteenth century, with a few not very important exceptions, which I have mentioned in a note,* were trained at home and were thrown in unusual degree upon the results of their own experience. While in the main their practice is not known to have differed from that which prevailed at the time, there is evidence of some local peculiarities. There developed early in Connecticut that special interest in the indigenous materia medica which, transmitted in direct succession from Jared Eliot, through Benjamin Gale, Jared Potter and Eneas Munson, became a distinguishing characteristic of Eli Ives and William Tully, the professors of materia medica and therapeutics in the Yale Medical Institution in its early years. This contributed to a less violent system of treatment of diseases than was customary in those days. Even in early colonial days a mild treatment of fevers prevailed in New Haven, according to Hubbard, who in writing of this town in his History of New England recorded that "The gentle conductitious aiding of nature hath been found better than sudden and violent means of purgation or otherwise; and blood-letting, though much used in Europe for fevers, especially in the hotter countries, is found deadly in this fever, even almost without

* The notes accompanying this address are omitted from this publication.

exception." In all probability the unusual success achieved by Benjamin Gale and certain other Connecticut physicians in the inoculation and treatment of smallpox is to be attributed to the mild, cooling and open treatment which they adopted, rather than to the preliminary mercurial treatment to which they ascribed it. These tendencies, for they were only such, did not find, however, their full expression until the appearance of Nathan Smith's work on 'Typhous [typhoid] Fever' in the next century.

Connecticut physicians were pioneers in the work of organization of the medical profession, and in this work graduates of Yale were prominent. The oldest existing medical society in this country is the still active and flourishing Litchfield County Medical Society founded in 1765 and preceded only by two short-lived voluntary organizations, one in Boston and the other in New York.

The first organized effort on the part of the profession to secure effective legal regulation of medical practice in the colonies was in 1763 when physicians of Norwich, Conn., petitioned the General Court for an act of incorporation, which was, however, not granted. The name of Elisha Tracy of the class of 1738 appears among the signers of this interesting memorial. This first unsuccessful attempt was the beginning of a series of efforts which, largely through the initiative of the Medical Society of New Haven County, organized in 1784, resulted in the incorporation of the Connecticut Medical Society in 1792. In the meantime State medical societies had been formed in New Jersey (organized in 1766, incorporated in 1790), Massachusetts (1781), Delaware (1789) and New Hampshire (1791).

The charter of the Connecticut Medical Society is, in most respects, an admirable instrument, and, as regards the organiza-

tion of State medical societies, historically almost as interesting as the famous Connecticut constitution of 1639. It embodies in a simple and practical fashion democratic and federative principles of organization and government resembling those adopted by the Commonwealth, and remains to this day a model for similar societies in other States. Of those concerned in the establishment of this Society graduates of Yale were the most active and influential, and they compose over one-third of the charter members. The first president was Dr. Leverett Hubbard (Y., 1744), and upon his death Dr. Eneas Munson (Y., 1753), was chosen his successor and held the office for seven years.

The most noteworthy contribution to medical literature before the Revolution by a graduate of Yale was Benjamin Gale's (Y., 1733) 'Historical memoirs relating to the practice of inoculation for the smallpox, in the British-American provinces, particularly in New England,' published in 1765 in the *Philosophical Transactions* of London. This creditable and historically interesting paper attracted attention both here and abroad, chiefly on account of its advocacy of the mercurial treatment before inoculation. It may here be mentioned that one of the most valuable of the Yale bicentennial publications, the 'Literary Diary' of President Ezra Stiles, edited by Professor Dexter, contains some interesting historical matter upon this subject of mercurial inoculation, as indeed it does relating to a number of other subjects of medical interest.

After the war of independence we find in American medical writings greater productivity and originality than before, attributable largely to the increased medical and surgical experience gained during the war, and to the higher degree of self-reliance, engendered by the political conditions.

The first original separate medical work in this country after the close of the Revolutionary war was the volume published in New Haven in 1788, entitled, 'Cases and Observations by the Medical Society of New Haven County in the State of Connecticut.' This publication, which contains twenty-six papers reporting cases of disease and autopsies, is an event of importance in American medical bibliography, not so much on account of the intrinsic value of the communications, although several are interesting, but because, in evidence of the newly-awakened medical life of the young republic, there is collected here for the first time a series of independent, original observations and studies by different American physicians. Nothing of the kind had appeared before in this country. One-third of the contributors to this volume are graduates of Yale.

Nine years later, in 1797, was started the first American medical journal, *The Medical Repository*, published in New York, and its projector was the talented and scholarly Elihu Hubbard Smith of the class of 1786, with whom were associated Dr. Samuel L. Mitchell and Dr. Edward Miller. Dr. Smith, the father of American medical journalism, died much lamented the following year. Although so young, he was physician to the New York Hospital, the editor of several works, and a contributor to literary periodicals as well as to his own journal, in which his scholarly papers on the plague of Athens and the plague of Syracuse can still be read with pleasure and profit. The establishment of *The Medical Repository*, which was continued until 1824, was of great service in promulgating medical knowledge and stimulating medical thought and writing in this country at the close of the eighteenth and in the early years of the nineteenth centuries.

The graduate of Yale, however, whose published contributions in the eighteenth

century are of the greatest permanent value to medicine was not a physician, but was that useful and versatile man, Noah Webster, of the class of 1778. Noah Webster is the first epidemiologist which this country has produced. In 1796 he published 'A collection of papers on the subject of bilious fevers, prevalent in the United States for a few years past,' and in 1799 appeared in two volumes a work, well known to all students of epidemiology, entitled, 'A brief history of epidemic and pestilential diseases,' which is of unusual interest, and on account of its records and observations of epidemic diseases in this country has an enduring value. There are scattered papers by him on various medical subjects, and one of these buried in *The Medical Repository* (Second Hexade, Vol. II.) should be rescued from forgetfulness. In this critique of Erasmus Darwin's theory of fever Noah Webster gives a well-reasoned, clear and definite presentation of that modern theory, associated with Traube's name, which explains febrile elevation of temperature by the retention of heat within the body.

NINETEENTH CENTURY.

With the turning of the century Yale College, under the guidance of the first President Dwight, passed not only in name but also in spirit from the eighteenth to the nineteenth century. It was transformed from a local to a national institution, and it entered upon a new era of expansion in which seeds were planted destined in the natural course of development to grow into the spreading tree of a university. The first fruit of this new university idea was the establishment of the Medical Department, some account of which will now engage our attention.

The need at that time of a medical school in this place is apparent from the fact that only eight or nine graduates of the

College before the foundation of the medical department in 1810 had received a medical degree in course, although a much larger number had spent a year in study at a medical school.

A part of the plan proposed in 1777 by a committee of the General Assembly to enlarge Yale College, provided a board of civilians was added to the corporation, included the establishment of professorships of medicine and of law. In the same year Dr. Stiles, before his entrance upon the duties of the presidency to which he had been elected, 'drafted a plan of an university, particularly describing the law and medical lectures,' to be laid before the committee of the General Assembly. These negotiations were at the time unsuccessful, and when at last in 1792 the closer union between the State and College was effected, these early proposals had dropped out of sight.

In two respects the circumstances attending the establishment of the Yale medical department are of peculiar interest. The initiative came from within the College and not from without, and the form of union between the College and the Connecticut Medical Society is something unique in the history of medical schools.

The idea of founding a medical department connected with the College unquestionably originated with President Dwight and was a part of his plan for extending the scope and usefulness of the institution. This broad-minded man was, as is well known, much interested in natural science, and he considered in his writings several matters of medical interest. One of the letters in his 'Travels in New England and New York' contains an argument, really remarkable in the light of our present knowledge, in support of his conclusion that malaria is caused by minute living organisms.

It is clear from several passages in the autobiographical reminiscences published

in Professor Fisher's 'Life of Benjamin Silliman' that at the time of Professor Silliman's appointment to the chair of chemistry and natural history in 1802 a medical department was definitely contemplated, and that his appointment was regarded as an important step toward that end. The plan had from this time the hearty sympathy and active support of Professor Silliman. 'Expecting,' as he says, 'from the first to be ultimately connected with a medical school in Yale College,' he attended both in Philadelphia and in Edinburgh, where he had gone mainly for chemical study, courses of lectures upon anatomy, materia medica, botany and theory and practice of medicine, coming under the influence of such famous medical teachers as Wistar and Barton in the former city, and James Gregory and John Barclay in the latter.

For centuries the medical departments of universities were the home of all that there was of chemistry and of other branches of natural and physical science, and it is significant that the medical department of this University came into being at the time when Benjamin Silliman had made New Haven the most important center for scientific work and influence in this country. It can hardly be an accidental coincidence that among the graduates of Yale College in the early years of Professor Silliman's teaching are found the names of such men as William Tully, Alexander H. Stevens, who represented medicine at the one hundred and fiftieth anniversary of this University; Jonathan Knight, Edward Delafield, John Wagner, Samuel H. Dickson and George McClellan, who became physicians and surgeons of national and international fame.

In 1806 the corporation of the College passed a resolution for establishing a medical professorship, and the Rev. Dr. Nathan Strong, of Hartford, who introduced the

resolution, and Professor Silliman were appointed a committee to examine and report, and to devise means for effecting the object.

It is to be emphasized that the Medical Department is the direct offspring of Yale College, and was not started, as nearly every other medical school in this country has been, by a group of outside physicians who have subsequently sought connection with a college. Even if there were no other claims, this origin should entitle the Yale Medical School for all time to the fostering care and support of its parent.

In order to understand the occasion for the negotiations which now ensued between the corporation of the College and the Connecticut Medical Society, it is to be borne in mind that this Society was possessed, through its charter of 1792, of unusual prerogatives which gave it control of medical education in this State. It was not only an examining and licensing body, which was proper, but also a degree-conferring body, which was decidedly improper and a usurpation of a function which should belong only to a college or university. From the beginning the Society had actively exercised all of these functions, and had furthermore made several regulations, which it was empowered to do, regarding medical education.

It was evidently necessary for the College to come to some sort of understanding with the Medical Society, and to induce it, if possible, to relinquish some of its chartered privileges.

It is not necessary here to enter into the details of these negotiations between the College corporation and the Medical Society, which extended over three years, especially as these have been fully set forth in a readily accessible paper by Dr. E. K. Hunt, a generous benefactor of the Medical School. Suffice it to say that concessions were made on both sides, and that, largely through the

efforts of President Dwight and Professor Silliman, representing the College, and of Dr. Eli Ives, representing the Medical Society, a satisfactory and amicable arrangement was reached, apparently without a great deal of friction, and was embodied in 'Articles of Union,' which constitute the act creating 'The Medical Institution of Yale College,' passed by the General Assembly in 1810 at the October session.

This act fixed the number of professors at four ('to include a complete circle of medical science'), the price of the ticket, and the time of examinations; provided for the establishment of a botanical garden, and of collections in anatomy and in materia medica; for a joint committee of an equal number of persons from the Medical Society and the corporation to nominate professors to be chosen by the corporation, and also for a like joint examining board, in which the president of the Society had the casting vote in case of a tie; repealed the right of the Society to grant honorary degrees in medicine, which could thereafter be conferred by the president of the College upon recommendation of the Society; provided that each county could send, upon recommendation of the Society, a gratuitous student, and fixed the term of medical study for college graduates at two years, and for others at three years, attendance upon a single course of lectures being requisite for the license, and upon two courses for the doctorate.

It is evident from this summary that the Connecticut Medical Society shared to a considerable degree with the College the control of the Medical Institution. I do not suppose that the College would have entered into this agreement with the Medical Society, had not the circumstances been such as I have mentioned. Nevertheless this union between the College and the State Medical Society had at that time distinct advantages, the most important of

which was the securing of the active interest of the physicians of the State in the new institution. In general the circumstances connected with the foundation and conduct of most medical schools in this country have not been calculated to secure the interest and sympathy of the great body of the medical profession.

No more competent testimony to the benefits derived from the union which existed here could be desired than that of Dr. Jonathan Knight, who says, in his introductory lecture in 1853: "The result of this arrangement has been eminently happy; all unpleasant feeling was at once and forever allayed; the members of the Society became interested in the School; we have at all times had the benefit of their council and support, and it gives me pleasure to state that no instance of disagreement has ever arisen among the members of the board, or between the School and State Society; on the contrary, each has regarded the other as a fellow laborer in the endeavor to promote and advance the interest of medical science."

The relations continued harmonious throughout the remaining period of existence of the agreement between the Society and the Medical School, but with changed conditions the union ceased to be useful and in some ways had become embarrassing, so that in 1884, by mutual consent, it was annulled, and the entire control of the School, the official name of which had meantime been changed by the new charter of 1879 to that of 'The Medical Department of Yale College,' passed into the hands of the University.

The charter of 1810, by its limitation of the number of professors and of the period of undergraduate medical study and its regulation of other matters better left to the discretion of the College, was an extremely inelastic instrument, and it is not surprising that repeated legislative changes

were found necessary. There have been not less than four distinct charters of incorporation of the Medical School, and in addition five or six amendatory acts. The present charter, which seems to be free from the defects of its predecessors, was enacted in 1879.

At the time of its incorporation in 1810 the Medical Institution of Yale College was the sixth medical school in the United States, the others being the medical department of the University of Pennsylvania, founded in 1765, the College of Physicians and Surgeons in New York, founded in 1807, but a descendant of the medical department of Columbia University, established in 1768, and the medical departments of Harvard (1783), of Dartmouth (1797), and of the University of Maryland (1807).

A commodious stone building on Grove Street, erected by Mr. James Hillhouse, was obtained for the use of the Medical School, and in 1814 this with an adjacent plot of ground was purchased by the aid of a generous donation by the State of twenty thousand dollars, obtained largely through the efforts of Dr. Nathan Smith. This building, which is now South Sheffield Hall, was the location of the Medical School until its removal in 1859 to its present site on York Street.

The members of the first faculty of the Medical School, appointed in 1812, were, in the order of arrangement of their names in the College catalogue, Eneas Munson, professor of materia medica and botany; Nathan Smith, professor of the theory and practice of physic, surgery and obstetrics; Eli Ives, adjunct professor of materia medica and botany; Benjamin Silliman, professor of chemistry and pharmacy, and Jonathan Knight, professor of anatomy.

Dr. Munson, to whom I have already referred, was an octogenarian at the time of his appointment, which was, as was intended, only an ornamental one, Dr. Ives, the adjunct professor, his pupil and friend,

performing the active duties of his chair. The remaining members of this faculty made a group of medical teachers who could challenge comparison with any similar group in this country. Of Benjamin Silliman it is not necessary for me to speak further, as his most important work lay outside of the immediate field of medicine, and will be considered by another speaker.

Dr. Nathan Smith, when he came to New Haven from Dartmouth, was already a star of the first magnitude in the medical firmament. Starting a poor boy in a small village in Vermont, he managed by his own efforts to obtain a good general education and then at the Harvard Medical School and in Great Britain a medical education of a character then almost unknown in New England. He was the originator of the Dartmouth Medical School in 1797, the most distinguished member of the first medical faculty of Yale, and in 1820 the organizer of the Medical Department of Bowdoin College. He did much of his most important work in New Haven, where he remained until his death in 1829.

Nathan Smith shed undying glory upon the Yale Medical School. Famous in his day and generation, he is still more famous to-day, for he was far ahead of his times, and his reputation, unlike that of so many medical worthies of the past, has steadily increased as the medical profession has slowly caught up with him. We now see that he did more for the general advancement of medical and surgical practice than any of his predecessors or contemporaries in this country. He was a man of high intellectual and moral qualities, of great originality and untiring energy, an accurate and keen observer, unfettered by traditions and theories, fearless, and above all blessed with an uncommon fund of plain common sense.

Nathan Smith's essay on typhus fever, published in 1824, is like a fresh breeze from

the sea amid the dreary and stifling writings of most of his contemporaries. The disease which he here describes is typhoid fever, and never before had the symptoms been so clearly and accurately pictured. He recognized that this fever is due to a specific cause and is self-limited. It took courage in those days for a physician to write, "During the whole course of my practice I have never been satisfied that I have cut short a single case of typhus, which I knew to be such," and again, "It does not follow of course that this disease in all cases requires remedies, or that a patient should necessarily take medicine because he has the disease." To him the lancet was not the '*magnum donum Dei*' that it was to Benjamin Rush, and he did more to do away with its indiscriminate use than any single man. The treatment which he advocated—cold water, milk, and avoidance of all violent remedies—is practically the same as that now employed, but it was many a day before physicians came to accept Dr. Smith's revolutionary views.

To the surgeon Nathan Smith's paper on the pathology and treatment of necrosis has in course of time become as much of a classic as the essay on typhus fever is to the physician. Here we find the same admirable description of symptoms, and the introduction of methods of treatment which anticipated modern surgery. This is not the occasion, even did time permit, to describe Dr. Smith's achievements in surgery. It must suffice to say that he was the first to perform a number of important surgical operations, and that in this branch, not less than in medicine, he was an innovator and reformer.

Although none of Dr. Smith's colleagues can be placed in the same rank with him as contributors to medical knowledge, they were men of excellent attainments and became distinguished teachers.

Dr. Eli Ives was connected with the

Medical School until his death in 1861, having succeeded to the professorship of theory and practice of physic upon the death of Dr. Smith in 1829, and becoming emeritus in 1853. He was a highly respected physician of large practice in this city. He was widely known as a botanist, and was credited with the most extensive knowledge of the indigenous *materia medica* of any man of his day, a taste for which he had acquired from his preceptor, Dr. Munson. His mind was richly stored with facts, and all were impressed with the value of his teachings.

Dr. Jonathan Knight, who was only twenty-three when appointed professor, became one of the most influential men in the medical profession of this country, having been twice president of the American Medical Association. He was transferred to the chair of surgery upon the death of Dr. Hubbard in 1838. Of dignified personal appearance and manner, with well-balanced mental powers, and fine literary culture, Dr. Knight has probably never had his superior in any medical school in this country as a finished lecturer. He was an active teacher in the Medical School for fifty-one years, dying only a few months before Professor Silliman, the latest survivor of the first medical faculty.

With this able and devoted group of teachers and a class of thirty-three students the Medical School began its work in November, 1813. To follow in detail its history from that day to this would far exceed the limits of this address. I regret that I can do no more than make mention of some of the professors who have passed to the majority: Thomas Hubbard, of necessity an inadequate successor of Dr. Nathan Smith in the chair of surgery, a plain, self-taught man, of whom Dr. Knight says that he filled his position to the time of his death in 1838 'with great and increasing reputation to himself and benefit to the institu-

tion'; William Tully, a really remarkable man, of whom I had hoped to say much more, erudite, original, an experimentalist, unrivaled in his knowledge of the *materia medica*, an extensive contributor to medical literature; Charles Hooker, of good scientific training, who had the great merit of introducing the newer medicine with its methods of physical examination into New Haven, a writer of valuable papers on auscultation and percussion and on physiological subjects; Henry Bronson, scholarly, devoted to antiquarian research, contributor of important papers on medical history and biography; Worthington Hooker, interested in medical education and the improvement of professional organization, a facile writer, widely known as a useful popularizer of natural science; Moses Clark White, for thirty-three years professor of pathology, who taught as early as 1860 the use of the microscope in medicine in this School; Leonard Jacob Sanford, a faithful teacher of anatomy for nearly a quarter of a century, devoted to the interests of the Medical School; James Kingsley Thacher, endowed with unusual intellectual powers and capacity for original scientific investigation, eminent as a comparative anatomist, abreast of modern physiology and clinical medicine, whose early removal by death was an irreparable loss to this Medical School and to medical and biological science.

While I refrain in general from mention of the names of those who are still living and are the faithful and able successors of these distinguished men, I cannot in this connection pass over the name of Dr. Charles Augustus Lindsley, a member of the medical faculty for thirty-seven years and its executive officer for twenty-three years, a devoted teacher and eminent sanitarian.

The period of greatest prosperity of the Medical School, until quite recent years, was the first two decades of its existence, in which the average annual attendance of

students was between 70 and 80. The annual attendance then fell to an average of between 30 and 40 for the four decades from 1850 to 1890. Since 1895 it has for the first time exceeded 100. Up to 1894 the largest class was that of 1822, which numbered 92, the largest number of graduates in any year up to 1897 being 36 in 1829. Of the 1,221 graduates of the medical department up to and including 1900, 27.6 per cent. were also college graduates, and of these three-fourths were graduates of Yale College or the Sheffield Scientific School. The highest ratio of college graduates (40.6 per cent.) was in the decade 1881 to 1890, when the total number of graduates was smallest.

It is pleasant to recall that the medical department, established through the efforts of the first President Dwight, entered upon a second era of prosperity in the administration of the second President Dwight, who in his annual reports has forcibly presented the needs and the possibilities of this first offspring of the College.

The standards of the Yale Medical School have always been kept high in comparison with those prevailing at the time, and at certain periods the School has taken the lead in movements to improve medical education, which from about the end of the third to the middle of the eighth decades of the past century was in a woeful plight in America.

At the beginning the course of medical lectures here extended through six months, a longer period than obtained at the time in any other medical school in this country.

The first organized effort to raise the standard of requirements for medical education in the United States was made by a Convention of Delegates from Medical Societies and Medical Schools which met in Northampton, Massachusetts, in 1827. The Yale Medical School faithfully conformed to the recommendations of this convention, and went to the trouble of securing in 1829

from the Legislature an amendment of its charter whereby the period of medical study was increased to four years for all who were not college graduates, and to three for graduates, and knowledge of Latin and of natural philosophy was required for matriculation. The Medical College soon found itself standing almost alone, 'faithful among the faithless,' and, in order to preserve its own existence, it was compelled after three years to return to the old order as regards the length of the period of medical study, although it retained the preliminary requirements, which, however, afterwards became inoperative, as they were so far above the demands of other colleges.

The inadequacy of the system of didactic lectures for the training of medical students was nowhere in this country earlier recognized than here. In 1855 the course was supplemented by daily recitations, and, as their advantages were realized, they received in the following years greater and greater emphasis, until they in combination with laboratory practice became, at least as early as 1867, a distinctive and certainly a valuable feature of the school.

In 1879 the Yale medical department placed itself in the front rank, as regards its standards, with only a few companions at that time, by introducing a stated matriculation examination and a three years' graded course, lengthened in 1896 to four years. Clinical instruction and the recitation and laboratory plan of teaching, which had been early adopted, continued to be the basis of the course. The thoroughness of the training is attested by the unusual success of the graduates of the Yale medical department in competitive examinations for positions in the army and in hospitals, and in State Board examinations for license to practice.

With the laboratory building erected in 1893, and the clinical building now in process of construction, the teaching re-

sources of the medical department have been greatly increased, and there is every indication that it has entered on a new era of success and usefulness, but it cannot reach the height of its endeavor or of the position properly belonging to an important department of this great University without a large increase of its present meager endowment.

Of the total number of physicians who have received their liberal education at Yale College and the Sheffield Scientific School, less than one-fifth are graduates of the Yale medical department, and it is pertinent to inquire how their alma mater has fitted them for their subsequent professional studies. For the great majority and until comparatively recent years this collegiate training was furnished by the old-fashioned classical course, and there can be no question but that this, combined with other influences of college life, gave an excellent discipline of mind and character, but with no peculiar adaptation to the study of medicine.

The advance of medical science and art during the last half century has given ever-increasing prominence to the value to the student of medicine of a good practical knowledge of chemistry, physics and general biology. It is to the great credit of this University that this need was first clearly recognized and supplied in this country by the Sheffield Scientific School, which in 1870 offered well-planned courses in these branches of science, announced as intended especially for the preliminary training of prospective medical students. With the establishment of the Laboratory of Physiological Chemistry four years later the distinctive pre-medical biological course was fully organized, and since 1889 this has been open also to students in the academical department.

No more convincing testimony to the importance of this new departure in collegiate

education is needed than the mere mention of the names of some of those who were graduated from the Scientific School in the ten years following the establishment of this course and who have acquired distinction in medicine or in sciences akin to medicine. Fortunately I can not illustrate my argument here by the selection of names from those who have passed away, and I trust that it will not be considered invidious if I cite names so familiar to physicians and biologists as those of Prudden, T. H. Russell, Hun, W. B. Platt, Chittenden, Yamagawa, Curtis, Sedgwick, Gilman Thompson, E. B. Wilson, Mitsukuri, H. E. Smith, E. A. Andrews, Ely. Not only has the laboratory of physiological chemistry under the direction of Professor Chittenden been of great service in the preparation of students for the study of medicine, but its contributions to a science of great medical and biological importance are unequaled in number and value in this country and have given it rank with the best laboratories of its kind in the world.

There have been all told not far from 2,300 graduates of Yale in all its departments (including the medical), who have become physicians, not counting twice the names of those graduated from more than one department. Of the graduates in arts (1702-1897) about 1,100 (9 to 10 per cent.) have entered the medical profession, the percentage being about the same for the eighteenth and the nineteenth centuries, but varying considerably in different years and decades, as appears from data which I have inserted in a note.* Especially significant is the fact that from the classes of 1822, 1824, 1825, 1826, and 1828, when the medical department was at the height of its early prosperity, the number of graduates in arts who became physicians was 80 per cent. above the general percentage

* The notes accompanying this address are omitted from this publication.

for the nineteenth century, and that over 41 per cent. of these received their medical degree from the Yale Medical School, as against 24 per cent. in general for the period since the opening of the medical department. Of the graduates of the Scientific School (1852-1897) at least 193 (9.1 per cent.) were later graduated in medicine, 22.3 per cent. of these receiving their degree from the Yale medical department.

It is of course out of the question to attempt to give here even the most summary account of the more than two thousand Yale physicians of the nineteenth century. Among those no longer living are the names of such famous men as Alexander H. Stevens, Samuel H. Dickson, George McClellan, Nathan R. Smith, William Power, Alfred Stillé, Samuel St. John, William H. Van Buren, Edmund R. Peaslee, J. Lewis Smith, Daniel G. Brinton, William T. Lusk and many others deserving of mention did time permit. The graduates of Yale in the medical profession have contributed their full share to the making of the medical history of this country. Over one hundred became professors in medical colleges, especially noteworthy being the number and distinction of those who have been and who are connected with the medical schools in New York City. At least thirty have been presidents of their State medical societies.

In all these two hundred years of her existence men have gone forth from Yale who have adorned the profession of medicine. Among them have been great teachers, leaders who have advanced medical knowledge, improved medical and surgical practice, and raised the standards of professional life and of medical education, men who have served their country in a professional capacity in peace and in war, and many more who have led the useful lives of general practitioners, honored in their homes and by their colleagues, and con-

tributing to the welfare of the communities where they have lived.

In centuries past the greatest renown of many universities lay in their medical faculties. There have been later times when the conditions of medicine and of medical education made it less fit to enter into the life and ideals of a university. It is not so to-day. Medicine has now become one of the great departments of biological science with problems and aims worthy of the highest endeavor of any university, surely none the less worthy because they are associated with human interests of the highest importance.

The union of medical school and university should be of mutual benefit. Medicine needs the influences of a university for its highest development, and the usefulness and fame of a university are greatly increased by a strong medical department. There is to-day no direction of scientific research more productive in results of benefit to mankind and in the increase of useful knowledge than that upon which medicine in these later years has entered, and there can be no nobler work for a university than the promotion of these studies.

But medical teaching and research can no longer be successfully carried on with the meager appliances of the past. They require large endowments, many well-equipped and properly-supported laboratories, and a body of well-paid teachers thoroughly trained in their special departments. With an ampler supply of such opportunities as these there is every reason to believe that the Yale medical department would take that important position in the great forward movement of modern medicine to which its origin, its honorable history and the fame of this ancient University entitle it. May the next Jubilee find medicine holding this high position in Yale University!

WILLIAM HENRY WELCH.

VARIETAL MUTATION IN THE TOMATO.

THE following remarks refer to the origination by mutation* of a strongly marked and distinct variety of tomato from seed of an old and well-known variety, under ordinary cultivation in an isolated garden plot; and to the subsequent duplication of that case of mutation upon the same ground and under the same conditions of cultivation, but in plants produced from other seed of that old variety, which was grown in a different and distant region. The mutation in these two cases is remarkable in that it was uniformly manifested in every plant of each of the two crops in which it occurred; that it produced plants which were widely different from the parent plants; that the second case was an exact repetition of the first, and that it occurred in both cases under circumstances that preclude the probability that it was the result of cross-fertilization.

My observations in these cases were made in connection with amateur gardening upon my house-lot in Washington, a statement of the results of which follows in narrative form. I chose the Acme variety of tomato for cultivation because of its long-known excellence, and the cases referred to occurred unexpectedly in the variety thus chosen. In the spring of 1898 I purchased a dozen young plants which had been produced from seed by a gardener in the vicinity of Washington, and transplanted them in my garden plot. As the plants matured and fruited they showed all the recognized varietal characteristics of Acme, a description of which is herewith given for the purpose of comparing it with other varieties presently to be mentioned. The plants were large and diffuse, the color of the foliage being a medium shade of green;

haulms slender, somewhat numerous, some of them reaching a length of more than six feet; the petiole-midrib long and slender; leaflets moderately narrow, distant, petiolulate and only slightly rugose; fruit depressed-globular in shape, with an occasional tendency to become transversely oval, uniformly ripened, fleshy and well flavored; and in ripening the change from the chlorophyl-green to crimson, passing through more or less of yellow.

I selected seeds from one each of the earliest and most characteristic fruits of several vigorous plants of this crop of 1898, and made a mixed packet of them. These seeds I planted in 1899, expecting to produce true Acme plants, because of my care in selecting and preserving the seeds, because of the comparative stability of that variety, and because no other tomato plants were grown with them, or in their neighborhood, from which cross-fertilization might have occurred. To my surprise, however, all the plants which grew from these seeds were distinctly different from the parent plants of the year before, both as to habitus and as to fruit, and all were uniform in their new characteristics. They were sturdy and compact plants with foliage of a deeper green than that of the parent plants; haulms few and strong, the more vigorous reaching a length of about four and a half feet, or an average of about two-thirds the length of the parent plants; petiole-midrib short and strong; leaflets moderately broad, not distant, sessile or nearly so, and strongly rugose; fruit similar to that of the parent plant in size, shape and consistence, but more delicate in color, which changes from the chlorophyl-green to cherry-red or light crimson through a neutral or flesh color, a yellow tint seldom appearing. It is also singularly free from the pronounced tomato flavor of the common kinds. The seeds which I saved from this new variety were accidentally destroyed

* In this article I use the term 'mutation' in the phylogenetic sense that has been given to it by Professor Hugo de Vries in his exhaustive work, 'Die Mutationstheorie,' Leipzig, 1901.

and I supposed the variety was therefore lost; but two years later I recovered it upon the same ground and under the same conditions of isolation and cultivation, but from a new source as to seed.

In the spring of 1900 I bought from a Philadelphia company of seed-growers a packet of their 'selected Acme Tomato' seed, grown and gathered on a Pennsylvania farm in 1899. From a part of these seeds I grew thirty plants to maturity, every one of which was true to the Acme variety as described in the second paragraph of this article. In this case also there was no probable source of cross-fertilization, and I carefully saved a mixed packet of seed selected from typical fruits of several of the best plants, as I did in the former case. These seeds I planted in my garden plot in 1901, not doubting that they would produce true Acme plants, notwithstanding my former experience. On the contrary, however, all the plants grown from those seeds were not only quite different from the parent Acme plants, but they were in all respects, both as to habitus and as to fruit, like those which grew upon the same ground in 1899, which are described in the third paragraph of this article, and which variety I believed was lost at the end of that year. That is, in 1900 and 1901 I exactly repeated my experience of 1898 and 1899, the second experience having been with seed from an entirely new source, as already stated. The new variety belongs to a group of varieties of which the two known to gardeners as the 'Potato-leaf Honor Bright' of Livingston and the 'Dwarf Champion' of Ferry, respectively, may be taken as types. It is quite a different group in several respects from that to which the Acme belongs. For convenience of reference I will designate this new variety as the 'Washington.'

When, in the spring of 1901, I planted the seed of the Acme plants which I had

grown in 1900, I at the same time planted the remainder of the Pennsylvania packet of Acme seed, carefully keeping separate both the seed and the resulting plants. The second portion of the Pennsylvania seeds produced true Acme plants, as did those of the first portion in 1900, and, although they grew vigorously, their fruit was more than two weeks later in ripening than was that of the Washington variety, thus adding another element of difference between the two varieties. This second planting was fortunate because it gave excellent opportunity to compare the two varieties with each other in all stages of their growth. As the plants of both varieties matured their differences of habitus became very conspicuous; indeed, it was readily observable with the appearance of the first leaves of the plantlets.

While all varieties of cultivated plants which are reproduced from seed are notably unstable in their varietal characteristics, some varieties, of even the same species, are more unstable than others. This varietal instability of cultivated plants is manifested in both mutation proper and atavistic reversion. The first is regenerative, and divergently progressive, especially in respect of results desired by the horticulturist, and the second, degenerative and convergently retrogressive. The tendency to mutation proper in cultivated plants is generally manifested in connection with selective cross-fertilization, but in view of my experience herein recorded, and of that of other persons in other cases, it cannot be doubted that it often occurs spontaneously in plants that have been fertilized only by pollen from those of their own variety. The tendency toward degenerative change in cultivated plants is apparently an inevitable result of promiscuous cross-fertilization, and is toward the primitive, uncultivated condition of the species. I, of course, assume that the Washington variety of tomato

herein described originated by spontaneous, saltatory mutation, without cross-fertilization, and that this form of mutation differs only in degree, not in kind, from the saltatory origin of new species which has been elaborately described and demonstrated by Professor de Vries in his work already referred to.

This manner of origination of the Washington variety of tomato is assumed for the following reasons: (1) No probable source of cross-fertilization was discovered by careful investigation; (2) all the new plants were identical with one another in their varietal character; and (3) the mutation in question was exactly repeated in a succeeding crop under like conditions of isolation and cultivation. If my Acme plants had received adventitious fertilization by pollen from any other than flowers of their conate crop-associates, the cross-fertilization would doubtless have been incomplete as to the whole crop and various as to the kinds of hybrids produced. Even if it were credible that the first case of complete mutation of my whole crop might have been the result of cross-fertilization from some unknown source, it would still be too much to believe that exactly the same result could have been produced a second time in succeeding years by such adventitious means.

Saltatory mutation may be said to have both a predisposing and an exciting cause, the former being always present, at least latently, and the latter acting only under the stimulation of changed conditions; but I do not propose to discuss the nature of either of them. While the exciting cause of saltatory mutation in plants very often acts in connection with the process of cross-fertilization, it sometimes, as has been shown, acts independently of it. In such cases as that which is here recorded one naturally seeks the exciting cause in some peculiarity of the physical conditions under which the plants grew. I by no means as-

sume that the exciting cause of the mutation which produced the Washington variety of tomato will be found in the physical conditions of my garden and its vicinity, but the following mention is made of those conditions, that they may be considered in any inquiry that may be made concerning it. My ground is in a northern suburb of Washington and, before the Civil War, it was part of a worn-out farm of stiff clayey soil. It is somewhat dry, but was watered freely with Potomac river water, especially during the hot summer months. It was fertilized with stable manure, lawn-mowings (used also as mulching) and crude sodium nitrate, the last about half an ounce to the plant, applied in weak solution near the roots. Besides the evident obscurity of the exciting cause of the case of mutation in question, when considered with, as well as aside from, reference to these conditions, it should also be mentioned that no similar case has been reported from other gardens around Washington in which tomatoes are grown, although practically the same conditions prevail in many of them that exist in mine.

That the mutation which produced my new Washington variety was not atavic, or retrograde, in character is shown by the horticulturally improved characteristics of the fruit, and by the fact that the entire habitus of the plant is unlike that of the parent Acme, and also unlike that of the plants from which the Acme was originally produced. In both fruit and habitus the new variety is also very unlike those common tomato plants and fruit to which all improved varieties sooner or later convergently revert under promiscuous cross-fertilization and careless cultivation. Although the Acme is one of the least unstable of the very many varieties of tomato which gardeners have recognized, its deterioration by atavic reversion is very common and is readily observable in the markets of Wash-

ington, where gardeners have brought the fruit during more than twenty years; but few of them have kept it pure. One may there trace the reversion through various grades from the typical to almost worthless kinds.

In view of all the facts that have here been stated, there seems to be no room for doubt as to the spontaneous, saltatory and phylogenetic character of the mutation which produced the Washington variety of tomato. Whether it will show the usual degree of varietal stability in future seed propagation, and whether any similar mutation will occur in other varieties of tomato under conditions similar to those of my garden, remain to be demonstrated.

CHARLES A. WHITE.

SMITHSONIAN INSTITUTION,
October 3, 1901.

SCIENTIFIC BOOKS.

A Treatise on Zoology. Edited by E. RAY LANKESTER. Part III. The Echinoderma, by F. A. BATHER, assisted by J. W. GREGORY and E. S. GOODRICH. London, A. and C. Black. 1900. Pp. vii + 344.

The student of zoology, if he wishes an elementary text-book, finds as great difficulty in making his selection as he does in buying a new bicycle or typewriter. Apparently the more advanced student will not be thus hampered by any embarrassment of riches, for it is doubtful whether any other work aims as high and attains as much as the volume under review.

The average worker who has added somewhat to his primary zoological training finds it a dreary and often fruitless performance to extract the new facts of science or the present state of knowledge on any particular topic from the almost endless collection of 'elementary' text-books, no matter how valuable they may be in fulfilling their true function. It is almost equally tiresome to sift out the same information from the great mass of technical papers on particular things. The present volume supplies in a large degree this deficiency for the Echinoderma, and is a most welcome addition

to general zoological literature. The entire series is planned to include ten parts, of which this is the third. Each of the larger groups of animals is to be described by a separate author after a definite model, in order to secure uniformity in both scope and method.

The general systematic survey of the phylum Echinoderma, with its seven classes, is quite full and comprehensive and includes the main facts of ontogeny, phylogeny, anatomy and classification. The orders and families are all clearly defined and most of the prominent genera are reviewed or mentioned. One of the striking features of this volume is the fulness with which the fossil forms are treated, thus according them their true value in any general treatise on echinoderm morphogeny. Instead of the starfishes and sea-urchins constituting the entire program, or 'whole show,' as they do in the minds of the average student and in half the text-books, here they form but the last two of the seven classes recognized, and the length of their discussion is in proper proportion. It is sincerely to be hoped that similar true values will be given among other classes, whether extinct or not.

The phylum Echinoderma comprises two divisions or grades, the Pelmatozoa and the Eleutherozoa. In the first are the classes Cystidea, Blastoidea, Crinoidea and Edrioasteroidea. In the second grade are the Holothuroidea, Stellerioidea and Echinoidea. This arrangement shows the unequal value of the classes and does not express their phylogenetic relations. The latter probably would be more truly represented, according to Bather, by placing a primitive class, Amphoroidea, at the base and deducing from it several lines of descent, namely, Edrioasteroidea, Anomalocystida, Aporita, Rhombifera and Diploporita. From the Edrioasteroid line, it is supposed, there sprang first Holothurians, then Stellerioidea, then Echinoidea. The Blastoids are included in the Diploporite line, and from them as a fresh development with a new lease of life arose the important class Crinoidea, whose discussion occupies, as is wholly proper, nearly one-third of the present volume.

The class Stellerioidea comprises the Asteroidea and Ophiuroidea, generally considered as quite distinct. Some recent genera, how-

ever, and many of the fossil forms, show that no clear line of separation can be drawn, though the names are still retained for simple convenience.

The usual primary subdivisions of the Echinoidea into two subclasses, the Palæechinoidea and Euechinoidea, have been abandoned and the older divisions, Regularia and Irregularia, adopted. The primitive ancestral Echinoid is unknown, though it is evident that the first forms were small sac-like bodies, with the mouth and anus at opposite poles and the muscular body supported by a series of angular plates, of which five pairs were perforated by pores. The thickening of the plates and the consequent loss of flexibility is believed to explain the reduction in the number of vertical rows taking place in the passage from paleozoic to neozoic genera.

C. E. BEECHER.

Studien über die Narcose, Zugleich ein Beitrag zur allgemeinen Pharmakologie. By E. OVERTON. Jena, Gustav Fischer. 1901. Pp. 195.

The chief object of these studies is the presentation of a new theory of narcosis which was put forward simultaneously but independently by Overton and H. Meyer. The essential point of the theory is that narcotics are such substances which are more or less soluble in the lipoids of the nerve cells, chiefly cholesterin and lecithin. However, as all substances reach the nerve cells only after being taken up by the blood and the lymph, they have in the first place to be soluble in the chief medium of these fluids—*i. e.*, water. The question, therefore, whether and in what degree a substance is a narcotic—*i. e.*, whether and in what degree it is able to enter into the nerve cell—depends upon whether and how much this substance is more soluble in fats than in water; in other words, the narcotic capacity of a substance depends upon the coefficient of its solubility in organic solvents divided by its solubility in water.

The book consists of two parts. The first part deals in an interesting and instructive way with the general aspect of the subject of narcosis. At the start the author shows that the distinction made by Claude Bernard, Dastre and other French writers, between anæsthetics

and narcotics cannot be maintained. Neither does the practical separation of the inhalation anæsthetics from the other narcotics have a scientific basis. There is, however, according to the author, a distinct difference between indifferent narcotics and narcotics of a basic character. The latter vary in their effects upon animals as well as plants from species to species; while the indifferent narcotics affect all vertebrates and some invertebrates in the same degree, provided the concentration of the narcotic within the blood of the animal is taken as a basis for the unit, and not the quantity of the narcotic used up in the production of the narcosis of the animal. The writer discusses the various steps which a narcotic has to pass through from its administration to the animal to its arrival in the body cells, and the different modes of penetration of the several layers of the cell, according to the compound employed as a narcotic. He then describes in detail the methods employed by Paul Bert, as well as those employed by himself, to obtain a constant concentration within the plasma of the blood of the volatile as well as of the non-volatile narcotics.

The author reviews the different theories of anæsthesia: hyperæmia, anæmia, Claude Bernard's semi-coagulation of the protoplasm, Dubois's theory of partial dehydration of the protoplasm. He quotes further Richet's rule that a compound is the stronger an anæsthetic the less soluble it is in water; and after reviewing our present knowledge of the presence of cholesterin and lecithin in the nerve tissues, he mentions that already as early as 1847 Bibra and Harless have suggested that there might be a connection between anæsthesia and the capacity of the anæsthetics to dissolve fats; and that L. Hermann has further suggested that cholesterin and lecithin of the ganglion cells might present the point of attack of the anæsthetics.

Turning to his own above-mentioned theory Overton states that he studied the solubility of the narcotics in olive oil, on account of the difficulty of obtaining sufficient quantities of lecithin, and describes in detail the physical and physiological methods employed by him for determining the division-coefficient (Thei-

lungs coefficient) $\frac{\text{oil}}{\text{water}}$ of the many indifferent and basic anæsthetics. His studies led him to the conclusion that the narcotic power of a compound depends in the first place upon its division-coefficient between the aqueous medium and the cholesterin-lecithin solvents of the organism, provided the absolute solubility of the compound in the cholesterin-lecithin solvent is not below a certain minimum.

In the second part detailed descriptions and tables are given of the numerous experiments made on a great many compounds, establishing in each one its division-coefficient and its narcotic power. The compounds comprise indifferent and basic narcotics, also antiseptics and antipyretics which possess more or less anæsthetic powers as secondary effects. The author draws from his numerous experiments the conclusion that the longer and the less branched the carbon chains of a compound are, the stronger is its narcotic power, and that the substitution of a hydrogen atom by a hydroxyl group diminishes, and the substitution by an alkyl group increases, the narcotic power of a compound. Overton thinks that the indifferent narcotics interfere probably in a physical way with the cholesterin and lecithin of the cells, while the basic narcotics interfere also with the protoplasm of the cell, hence the greater clinging of the latter group of narcotics to the cells and their deleterious effects.

Overton's book is a very valuable contribution to biology and pharmacology; it opens new fields and new methods of research and will prove to be a fruitful stimulus to student and investigator.

S. J. MELTZER.

NEW YORK.

Les matières colorantes naturelles. By V. THOMAS (Chef des travaux de chimie appliquée à la Faculté des Sciences de Paris). Une publication de l'Encyclopédie Scientifique des Aide-Mémoire. Publiée par Gauthier-Villars, Paris, sous la direction de M. Léauté (Membre de l'Institut). Pp. 180.

It is probable that no department of chemistry, during the past thirty years, has experienced a more marvelous development and

elaboration than that relating to the artificial dyestuffs. At the present time these synthetic dyes are numbered by the thousand, and millions of dollars are invested in their commercial production. Two of the largest chemical factories of the world are devoted to this industry, one employing over 200 trained chemists, the other over 160, practically all of them Ph.D. men from the universities. The relation between the structure of these dyestuffs and their tinctorial value has been definitely established for most classes of artificial colors, and the literature of the subject is vast in extent.

The result of this tremendous activity in the field of artificial colors has been that the natural colors have been correspondingly neglected, and it is only within quite recent years that attention has again been directed to these substances, many of which have been familiar since ancient times. These scattered researches upon the tinctorial constituents of plants used in dyeing have been collected, digested, and the results presented in a condensed form by the author. The work is ably and carefully done, the chapter upon the Flavone Colors being especially praiseworthy.

In this volume the author treats only those natural coloring matters which are commonly regarded as derivatives of benzophenone, xanthone or flavone, thus including the majority of the natural yellow dyes.

Each chapter opens with general statements concerning that particular group of colors, its history, development, etc. This is followed by a detailed description of the individual colors, giving history, preparation, properties, tinctorial value, etc., the reactions and syntheses by which the constitutional formula has been elucidated being clearly and concisely explained. References to original articles are numerous, and in some cases (*e. g.*, syntheses in the flavone group) quite extensive.

The separate chapters deal with the following colors:

I. Derivatives of benzophenone.—Maclurin and derivatives, catechin and derivatives, kinoin.

II. Derivatives of xanthone.—Indian yellow, euxanthone, gentisin and gentisein, datiscetin, paradatiscetin.

III. Derivatives of flavone (phenylpheno- γ -pyrone).—Chrysin, tectochrysin, apigenin, acacetin, luteolin, quercetin, rhamnetin, isorhamnetin, rhamnazin, fisetin and derivatives, morin, myricetin, k  mpferid, galangin, loto-flavine.

The volume concludes with an alphabetical table of the coloring matters and their derivatives, giving the name of the compound, its melting point, and the reference to the page of the text where the same may be found described in detail, thus constituting an excellent index.

The book presents an able review of a field which is frequently unjustly slighted in the larger text-books. It can be heartily commended to those interested in this branch of organic chemistry.

MARSTON TAYLOR BOGERT.

Pflanzenphysiologie. Ein Handbuch der Lehre vom Stoffwechsel und Kraftwechsel in der Pflanze. Von DR. W. PFEFFER. II. Kraftwechsel. Zweite vollig umgearbeitete Auflage. Leipzig, Wm. Engelmann. 1901. Pp. 353.

The first volume of this comprehensive work appeared in 1897 and was reviewed by the writer of this note in *SCIENCE* (7: 318. 1898). The recent part deals with the general action of growth, and the influence of various factors upon it, the inherent causes of specific form, variation and heredity, rhythm and resistance.

The commendation given the first volume of this splendid work seems equally well deserved by the second. The citations of literature are quite inclusive up to 1900, and many of the more important papers appearing since that time are given, although not much time could have been given to a consideration of their contents.

It is to be said that the author has not had so much critical editorial work before him in the preparation of the present part as in the first volume, since the greater number of principles discussed are in the form in which they have been accepted for a decade. Much of the material rests exactly as it was left by Pfeffer's lengthy papers of a few years since upon transformations of energy, and in other sections the subject matter has remained almost undisturbed since the first edition of the book.

Some of the phases of the activity of the plant discussed do not appear to have been carried to the extent that might be reasonably expected from a work of this character. Thus in dealing with the influence of light upon plants, the author has not followed to a logical conclusion the discussions foreshadowed in the preface.

The influence of water content upon growth and form, correlation, reproduction and regeneration comes in for a well-conceived treatment, and the pages devoted to these topics are valuable additions to literature.

The first volume has already been translated by Dr. Ewart in a manner adding much to its scientific and practical value, and it is to be hoped that he will be as speedy and attentive in editing the present volume. An unusually large number of typographical errors will doubtless be reduced to a minimum in the process.

The fulness of discussions, exactness and pertinence of citations, together with the grasp of the subject and breadth of view of the author, make this book very easily the greatest work yet produced on plant physiology, and in the historical development of the subject it will prove to be as valuable as the notable volume of Sachs.

D. T. MACDOUGAL.

SCIENTIFIC JOURNALS AND ARTICLES.

THE October (closing) number of Volume 2 of the *Transactions of the American Mathematical Society* contains the following papers: 'Geometry of a Simultaneous System of Two Linear Homogeneous Differential Equations of the Second Order,' by E. J. Wilczynski; 'Theory of Linear Groups in an Arbitrary Field,' by L. E. Dickson; 'On Certain Aggregates of Determinant Minors,' by W. H. Metzler; 'Ueber die Anwendung der Cauchy'schen Multiplicationsregel auf bedingt convergente oder divergente Reihen,' by A. Pringsheim; 'Ueber den Goursat'schen Beweis des Cauchy'schen Integralsatzes,' by A. Pringsheim; 'New Proof of a Theorem of Osgood's in the Calculus of Variations,' by O. Bolza; 'On Certain Pairs of Transcendental Functions whose Roots Separate each other,' by M. B  cher; 'On the System of a Binary Cubic and a Quadratic and the

Reduction of Hyperelliptic Integrals of Genus Two to Elliptic Integrals by a Transformation of the Fourth Order,' by J. H. McDonald; 'On the Theory of Improper Definite Integrals,' by E. H. Moore; 'On the Convergence and Character of a Certain Form of Continual Fraction,' by E. B. Van Vleck; Notes and Errata, Volumes 1 and 2.

The October number (Volume 8, No. 1) of the *Bulletin of the American Mathematical Society* contains the following articles: 'The Eighth Summer Meeting of the American Mathematical Society,' by F. N. Cole; 'The Ithaca Colloquium,' by Edward Kasner; 'Upon the Non-Isomorphism of two Simple Groups of Order $8\frac{1}{2}$,' by Ida M. Schottenfels; 'Concerning Surfaces whose First and Second Fundamental Forms are the Second and First Fundamental Forms respectively of another Surface,' by Alexander Pell; 'Notes,' and 'New Publications.' The November number of the *Bulletin* contains: 'On Wronskians of Functions of a Real Variable,' by Maxime Bôcher; 'The Configurations of the 27 Lines on a Cubic Surface and the 28 Bitangents to a Quartic Curve,' by L. E. Dickson; 'The Fiftieth Annual Meeting of the American Association for the Advancement of Science,' by G. A. Miller; 'Riemann-Weber: Partial Differential Equations of Mathematical Physics,' by J. S. Ames; 'Notes,' and 'New Publications.'

SOCIETIES AND ACADEMIES.

AMERICAN PHYSICAL SOCIETY.

THE fall meeting of the American Physical Society was held at Columbia University on Saturday, October 26, President Michelson presiding. The first paper, by F. L. Tufts, described experiments on the effects of stationary sound waves on unignited gas jets. The disturbances caused in such jets by sound waves were made visible by means of the 'Schlieren Methode,' the source of illumination being the spark of an induction coil. The jet was found to assume a vibrating sinuous form, with increased amplitude at greater distances from the orifice. The results could be explained upon the assumption that the initial velocity of the gas, upon issuing from the orifice, is the re-

sultant of its own proper velocity and that due to the vibration of the sound wave. Photographs of unignited jets when disturbed in this way were shown. A second paper by Mr. Tufts dealt with experiments with the ordinary organ pipe. The Schlieren method was applied in this case to show the vibrations of the blast of air blown against the tongue of the pipe, and photographs were shown which gave excellent confirmation of the usual theory of the action of such pipes.

A note on the use of the Arons' mercury lamp as a source of illumination in certain color experiments was presented by Ernest Merritt. The light from the mercury arc is chiefly due to three lines in its spectrum, lying respectively in the violet, the green and the yellow. These lines are sufficiently near to the three primary colors to make the light of the lamp seem not greatly different from white; but when the lamp is used to illuminate colored objects the absence of the red is rendered evident. Red objects, for example, usually appear black when seen by this light. When a selection is made from colored worsteds, such as are used in the ordinary test for color-blindness, the selections are much the same as those made by a red-blind individual.

After the noon recess the Physical Society joined with the Mathematical Society during the reading of a paper by M. Hadamard on the 'Theory of Elastic Plates.' In the afternoon session a note was presented by Wm. Hallock on 'Measurements of Subterranean Temperatures,' in which were given the results of the most recent work on this subject. An instrument for the measurement of entropy was described by A. G. Webster. This 'entropy meter' had not been actually constructed, nor did the speaker think that it would make a very practical apparatus. It showed a possible method, however, by which entropy changes might be automatically registered and measured. Mr. Webster also reported the results of experiments upon the audibility of sound over grass and water. It was found that under similar conditions of quietness, etc., a given sound could be heard almost exactly four times as far over water as over grass. The assumption that water is a perfect reflector, while grass

is a 'black body' toward sound waves, is not sufficient to explain this difference.

ERNEST MERRITT.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 342d meeting was held on Saturday evening, November 2.

Mr. H. J. Webber exhibited specimens of the pineapple suffering from the disease termed 'root bind.' This was caused by planting improperly trimmed cuttings, which caused the roots as they developed to wind tightly around the stalk, causing defective nutrition and finally death.

Charles Louis Pollard gave some 'Notes on a Trip to Mount Mitchell,' made during the present spring for the purpose of obtaining botanical specimens and of studying incidentally the distribution of certain species of violets.

H. J. Webber described 'A Cow Pea Resistant to Root Knot Worm,' stating that in examining an extensive series of cow peas and other plants this one variety had been found entirely free from the parasites, although growing immediately between two varieties that were badly affected. The root knot worm, a small nematode, not only affected cow peas, but very many plants, doing serious damage, and the finding of the cow pea led to the hope that other plants might be found equally resistant, while by planting the pea as an alternating crop it would be possible to lessen the numbers of the worms.

Frederick V. Coville gave an 'Exhibition of Specimens of Alaskan Willows,' including examples of all species from that region. For descriptive purposes the speaker grouped these willows in three divisions, the tree, bush and procumbent forms, exhibiting a series of slides showing the floral divisions of Alaska and illustrating the habitat of the various groups. The different species were described in some detail as to their range, abundance or rarity, date of discovery and economic value when the species was of sufficient size.

M. A. Carleton spoke of the 'Characteristics and Distribution of Xerophytic Wheats,' illustrating his remarks with lantern slides of the Russian wheat region. The speaker said that wheats were grouped in eight divisions: (1) Common; (2) Club or square head; (3) Poulard;

(4) Durum or macaroni; (5) Polish; (6) Spelt; (7) Emmer; (8) Einkorn.

What might be called xerophytic or drought-resistant wheats belong to several of these groups, but the most important ones belong in the durum or macaroni wheat group. This is the group, therefore, which was chiefly discussed. These wheats differ from the ordinary wheats as now known in this country by having rather large flattened heads with large chaff and very large yellowish white grains which are extremely hard and vitreous in fracture, and often rather transparent. They always have beards, which are usually very long. In some varieties the heads and beards are black. These wheats are very resistant to drought, being able to grow where the rainfall is as low as ten inches per annum. They also resist the leaf rust very greatly, but are more or less subject to stem rust when it occurs in very great abundance. They are also seldom injured by bunt, smut or other diseases. Naturally they are adapted to semi-arid or arid regions, and at present are growing mainly in east and south Russia, Algeria, Argentina, parts of India and in various portions of the Orient and Mediterranean region. In this country they are especially adapted to our semi-arid plains from North Dakota to Texas.

The investigations of this department on the basis of soil and climate have led us to believe that those wheats will yield about one-third more to the acre in our semi-arid regions than other wheats, and what is more important, produce a constant yearly crop in large portions of that region where other wheat cannot be grown at all. Numerous practical tests have since proved this prediction to be justified. At the same time these wheats are the very best adapted for making macaroni, and there is now a great demand for them from this country, the people in Europe having learned of what good quality they are. Wherever they have been tried for the purpose, they also are considered to make excellent bread. In the establishment of these durum wheats we have a striking example of the beneficial results that may follow purely scientific investigations.

T. W. STANTON,
Secretary.

THE TORREY BOTANICAL CLUB.

AT the meeting of the Club on October 8 the scientific program consisted of informal reports of summer's work, including reports from Dr. Rydberg, of his visit to Sweden and Norway; from Mr. Murrill, of his attendance on the Botanical Congress at Geneva; from Mrs. Harris, of work among the lichens in the Adirondacks; and from Mrs. Britton, of work among the mosses there and in the Catskills, with advance notes reporting Dr. Britton's collection in the West Indies. Dr. Underwood spoke of his collecting in Porto Rico, examining thoroughly the eastern part of the island during five weeks spent there. He collected over 1,000 numbers of dried plants and sent back a large number of cacti now growing in the Botanical Garden. He was afterward in the Berkshire Hills for two weeks, then attended the A. A. A. S. meeting at Denver, Colorado, and spent some time in botanical work throughout many parts of that State, collecting about 600 numbers of the fall flora, particularly about Ouray and Pikes Peak.

The secretary reported extension of range of *Aster curvescens* by his discovery of its growth in quantity in the southern Berkshire Hills.

Dr. MacDougal reported his work in Montana where he aided in maintaining a summer laboratory for four weeks at Big Fork, at the north end of Flathead L., and entertained Dr. H. C. Cowles and twenty students of the University of Chicago. Dr. MacDougal then joined a collecting party exploring a part of northern Montana not known to have been before visited by a botanist, except as Canby gave it a flying trip in 1884. Dr. MacDougal collected about 900 flowering plants. Some days of every week the work was among snow and ice, with alpine flora, lakes a mile long of snow-water, chiefly without outlet and without life, as they freeze solidly to the bottom. He exhibited a panoramic view of the mountains seen across Flathead L., with numerous photographs showing the technique of collecting and camp equipment.

Dr. M. A. Howe reported on his eleven weeks' collecting trip for marine algæ in Nova Scotia and Newfoundland. He made about ten principal stays of a week each, at Yarmouth, Digby, Grand Pré; at Pictou, a station for

Fucus serratus, and where he obtained it in quantity; at Cape Breton; on the south end of Newfoundland, the richest locality in the larger kelps. There and along the south and east coast of Newfoundland is almost treeless, as is generally reputed, but firewood and lumber are obtainable 20 miles inland, and the west shore is forested with spruce, fir and tamarack, with yellow and white birch. Journeying east through the practically uninhabited interior, a thin coniferous forest was met, especially all around the numerous lakes. Where fires had been through it, for 20 or 30 miles, all was a flaming purple of fire-weed (*Epilobium*).

Dr. Howe mentioned the current names for the three native berries eaten so commonly there, *squashberry* for *Viburnum pauciflorum*; *baked apple berry* for *Rubus chamæmorus*; and *partridge berry* for *Vaccinium vitis-idaea*, called Swedish cranberry in parts of the U. S. where imported from Scandinavia. Dr. Howe remained four weeks in Newfoundland, and was afterward at Halifax Harbor, N. S., where Harvey, author of the *Nereis*, had made important collections.

Dr. R. M. Harper reported collecting again in Georgia, with about 500 numbers, visiting many new localities, traveling about 1,400 miles by rail, and doing much work on plant-distribution. He spoke particularly of the remarkable flora of the sandhills in Bulloch Co., resembling the 'scrub' flora in Florida. Photographs of these and other parts visited were shown. Along shady banks of the Chattahoochee River, some 50 miles from Columbus, he found some southern species, reaching their northern limit. In the Pine Mountains, southernmost eastern extension of the Appalachians, he found on the northern slopes an interesting mixture of Southern and Northern species. The southern slopes are covered with the long-leaved pine, with the flora characteristic of the pine barrens of the southern coastal plain. Among the interesting plants collected by Mr. Harper were *Elliotia* and, at Thomasville, Ga., *Nymphæa orbiculata*.

Brief remarks followed regarding fall blossoming and foliation in New York City, and Dr. Underwood exhibited a fresh specimen of *Botrychium dissectum*. It was noted by Mrs. Britton

and others that the maples, lindens and button-woods in Union Square, Washington Square and Madison Square are now covered with fresh leaves as in May, owing to defoliation by caterpillars; that the catalpas, honey locusts and poplars were but little eaten, and are not, therefore, covered with fresh leaves, but were injured by an early drought, and have sent out new shoots to replace those lost; these new shoots are now covered with fresh young leaves. The English elms in Washington Square were little eaten and have no new leaves. Horse-chestnuts have new shoots and some have new blossoms. Cherry trees have also been in bloom again. The magnolias and tulip trees of Bronx Park have blossomed and fruited twice this year.

EDWARD S. BURGESS,
Secretary.

THE SCIENCE CLUB OF THE UNIVERSITY OF
WISCONSIN.

THE first meeting of the Science Club of the University of Wisconsin for the present college year was held on Thursday evening, October 31. The newly elected officers of the Club are: President, Professor W. W. Daniells; Vice-President, Professor Wm. H. Hobbs, Secretary and Treasurer, Professor L. S. Smith.

Two papers of both scientific and economic interest were presented, the first by Dr. C. K. Leith, on the 'Mesabi Iron Range of Minnesota,' and the second by Professor C. R. Van Hise, on 'The World's Past, Present and Future Supply of Ores.'

Dr. Leith's paper was based on a monographic report on the Mesabi iron-bearing district of Minnesota which he is preparing for the U. S. Geological Survey. He sketched the marvelous development of the range from the time of its discovery ten years ago to its present position as the greatest iron range in the world. The range exhibits Archean, Lower Huronian and Upper Huronian rocks in typical development, and with relations so clear as to make the Mesabi almost a type district for these three pre-Cambrian series. The iron ores are confined to the 'iron formation,' which forms the middle horizon of the nearly flat-lying Upper Huronian series. The iron formation consists of ferruginous cherts, ferruginous

slates and iron ore, all of which give evidence of having resulted from the alteration of a rock made up of green ferrous silicate granules. The granules contain fifty per cent. silica and thirty per cent. ferrous iron, with little or no potash. They were called glauconite by Spurr, but their study by the U. S. Geological Survey shows them not to be glauconite of organic origin, but a ferrous silicate deposited on the sea-bottom through chemical reactions. The iron ores have resulted from the alteration of this type of rock through the agency of underground waters. The ores are now found where the action of these waters has been vigorous. These places are the southward-pitching troughs of the gently folded iron formation, and in the parts of the troughs lying along the middle slopes. The bottoms of the troughs are mainly slaty layers within the iron formation itself.

The iron-ore deposits of the Mesabi are similar to those of other ranges of Lake Superior in having resulted from the alteration of some earlier rock, in having been concentrated by underground water, and in occurring in troughs with impervious basements. However, in the Mesabi the rock from which the iron ores resulted is the green ferrous silicate, while in the other districts it is iron carbonate. In the Mesabi the pitching troughs containing the iron-ore deposits have very gentle dips and great horizontal dimensions, while the pitching troughs in the other ranges are narrow and sharp, and have great vertical dimensions. Finally, and possibly in some way connected with these features, in the Mesabi district the ores are exceedingly soft and friable, while the old range ores are fairly hard.

Dr. Leith illustrated the various methods of mining the Mesabi ores, the most striking of which is loading by steam shovels directly on to cars. He described also the great mines of the district, several of which are shipping over 1,000,000 tons of ore a year.

The amount of ore in sight on the Mesabi is roughly estimated at 500,000,000 tons, or about twice as much as there is in sight on all the rest of the Lake Superior ranges together. It is also far in excess of all the ore now known in other parts of the United States. The development of the Mesabi range has lowered the

price of ore for the American steel manufacturers; and this fact alone, regardless of any superiority in methods, would give them the advantage in foreign markets. In Europe at the present time the situation as to the iron ore supply, as to the demand for same, and as to prices, is not greatly dissimilar to what it might have been in the United States had no Mesabi range been discovered to ease the demand for old range ores and to lower prices. A great basal factor, then, in the superiority of the United States in the iron and steel trade is the Mesabi iron range. The United States Steel Corporation controls from 70 to 80 per cent. of this raw material, and hence its future influence on the iron and steel trade of the world may be conjectured.

Professor Van Hise followed with a brief general discussion of the world's past, present, and future supplies of ores. He called attention to the tremendous revolution in mining ores of all kinds which has occurred in the past century, and ventured the opinion that in the past fifty years more ore has been mined in the world than in all its previous history.

The above papers were discussed by Professor J. Morgan Clements. Professor Clements also summarized the relation of the work which the U. S. Geol. Survey has been doing in the Lake Superior region, as well as in other mining districts of the United States, to an intelligent exploration for ore deposits and the scientific development of the same when they are found.

A resolution of sympathy in memory of the late Professor Nelson O. Whitney, of the Engineering Faculty of the University of Wisconsin, presented by Professors J. B. Johnson, F. E. Turneure, and Louis Kahlenberg, was adopted by the Club.

L. S. SMITH.

THE SCIENTIFIC ASSOCIATION OF THE UNIVERSITY OF MISSOURI.

THE Association has elected the following officers for the ensuing year: President, Professor W. G. Brown; Vice President, Professor C. F. Marbut; Secretary, Dr. Charles Thom; Treasurer, Professor C. A. Ellwood; Chairman of Executive Committee, Dr. C. M. Jackson. At a meeting October 14, Professor H. B. Shaw displayed a series of lantern slides illustrating the

important features of the largest and most successful electrical plants in the United States. At its regular meeting on the last Monday night of each month a paper is presented embodying some original work done by the author. At its supplementary meeting held usually on the second Monday night, a popular presentation of some scientific subject offers each department an opportunity to present matters of general interest from any source.

CHAS. THOM,
Secretary.

UNIVERSITY OF MISSOURI.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis on the evening of November 18, twenty-four persons present, the following subjects were presented:

Mr. F. C. Baker, some interesting molluscan monstrosities.

Dr. Stuart Weller, Kinderhook faunal studies. III. The faunas of beds No. 3 to No. 7 at Burlington, Ia.

Professor William Trelease read an untechnical address on the progress made in botany during the nineteenth century.

One person was elected to membership in the academy.

WILLIAM TRELEASE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

THE PYTHON IN PENNSYLVANIA.

TO THE EDITOR OF SCIENCE: On August 9, a python, probably *Python natalensis*, was found in the grass on Presque Isle, Pa., by three young men from Erie who, as they supposed, killed it and took it to the city. However, it revived and was exhibited in the window of the Tribune bicycle store. On August 29 I measured and weighed it. The length was about seven feet four inches, greatest girth eleven and one-half inches; weight, seventeen pounds. That evening it pushed away the wire netting from one corner of its cage and escaped. It probably took up its residence under a building in the rear of the store, but had not been seen when last I heard, October 14. Reports of the liberation of large snakes in the vicinity of

Presque Isle I investigated, but they proved to be unfounded. Who can tell how this African snake found its way to the shore of Lake Erie and how long it had found subsistence there?

E. L. MOSELEY.

SANDUSKY, OHIO,
Oct. 27, 1901.

SHORTER ARTICLES.

THE UNEXPLAINED SOUTHERLY DEVIATION OF FALLING BODIES.

THE formula published by Mr. Roever, of Washington University (SCIENCE, July 12, 1901, p. 70), giving the southerly deviation of falling bodies due to the earth's rotation, is of special interest, because it marks a fresh attack upon a problem which in my 'History of Physics,' p. 75, I call an unsolved problem. The difficulty lies in a wide discrepancy between the theoretical and the observed results. The latter are over 1,000 times greater than the former.

1. *Experiments.*—When Robert Hooke undertook to verify experimentally Newton's prediction of an easterly deviation of falling bodies, due to the earth's rotation, he reported also a small southerly displacement.*

When in 1791 G. B. Guglielmini again undertook to verify Newton's prediction by a series of experiments from a tower at Bologna, a southerly deviation was again observed. He found H ('height' or distance fallen through) = 241 Paris feet (78.3 m.), $E. D.$ ('easterly deviation') = 8.375 lines (18.894 mm.), $S. D.$ ('southerly deviation') = 5.272 lines (11.894 mm.).†

In 1802 J. F. Benzenberg experimented from the St. Michael's tower in Hamburg. H = 235 feet (76.3 m.); $E. D.$ = 3.99 lines (9.00 mm.); $S. D.$ = 1.5 lines (3.4 mm.).‡

* See Ball, 'An Essay on Newton's Principia,' pp. 146, 149, 150.

† See Gilbert's *Annalen*, Vol. XI., p. 172; Vol. XII., 1803, p. 372; Vol. XIV., p. 222. Rosenberger, in his 'Geschichte der Physik,' Vol. III., p. 96, refers to Guglielmini's book, 'De diurno terrae motu, experimentis physico-mathematicis confirmato,' Bologna, 1792, but as early as 1803 the book is spoken of as being very rare.

‡ Gilbert's *Ann.*, Vol. XIV., p. 222. Rosenberger refers to Benzenberg's book, 'Versuche über die Gesetze des Falles,' Hamburg, 1804.

In 1804 Benzenberg experimented in a shaft of a coal mine at Schlebusch. H = 260 ft. (84.4 m.). An $E. D.$ was noticeable, but on selecting from the total number those experiments which, in his judgment, were made under the most favorable conditions, there seemed to be no indication of a $S. D.$ *

In 1831 F. Reich experimented in a mine-shaft at Freiberg. H = 158.5407 m., $E. D.$ = 28.396 mm., $S. D.$ = 4.374 mm. These results are deduced from six series of experiments. Altogether 106 balls were dropped. Reich's are the most carefully conducted experiments on the subject which have been made. Yet they differ much among themselves, though not as much as those of Benzenberg.†

In 1848 W. W. Rundell published experiments made in the shaft of a Cornish mine.‡ Balls were dropped through a distance of one-fourth of a mile and a $S. D.$ of 10 to 20 inches (25 to 51 cm.) was noticed. From the account of the experiments it is difficult to convince oneself that sufficient precautions were taken against disturbances from air-currents.

All observers experimented with metallic balls. Are these observed southerly displacements due wholly to experimental error? Though we may incline to that opinion, we cannot deny the force of Benzenberg's remark: 'Sonderbar bleibt doch diese Tendenz der Fehler nach Süden.'

2. *Theory.*—Mr. Roever is not the first to derive a formula for $S. D.$, due to the attraction of the rotating earth. This was done in 1803 by Gauss § and by Laplace.||

Neglecting the resistance of the air, Gauss obtained

$$E.D. = y = \frac{1}{2} \cos \phi \, g n t^3,$$

$$S.D. = x = \frac{1}{2} \cos \phi \sin \phi \, g n^2 t^4,$$

where u is the angular velocity of the earth, ϕ the latitude. Applying this to Benzenberg's

* Gilbert's *Ann.*, Vol. XVIII., p. 381.

† See Poggendorff's *Ann.*, Vol. XXIX., 1833, p. 494. Rosenberger refers to Reich's book, 'Fallversuche über die Umdrehung der Erde,' Freiberg, 1832.

‡ Robertson's *Mechanic's Magazine*, London, Vol. XLVIII., p. 485.

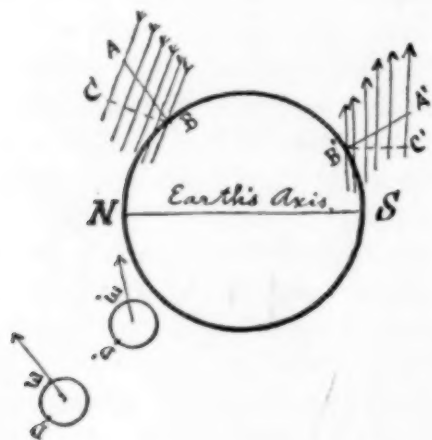
§ Gauss, 'Werke,' Vol. V., 1877, p. 495.

|| *Bull. d. sciences par la Soc. Philomath.*, Plairial an 11 (1803).

data, Gauss took $\frac{1}{2}gt^2 = 235$, $\phi = 53^\circ 33'$, $t = 4$ seconds, $nt = \frac{1}{315}$ spatial minutes, and $1' = \frac{1}{3438}$ radians. Gauss found E. D. = 3.91 lines, the experimental value being 3.99. The formula gives S. D. = .00046 lines, the experimental value being 1.5 lines.

The resistance of the air was found by both Gauss and Laplace to make no appreciable difference in the S. D. Several writers deduced formulæ which seemed to give a much larger S. D. than those of Gauss and Laplace, but in every case some error in the reasoning has been detected.* The deductions of Gauss and Laplace have, thus far, stood the test of criticism.

Other than gravitational agents were considered by Oersted and Sir John Herschel.† They suggested that the 'electric currents * * * known to be circulating around the earth in the direction of the parallels of latitude' induce currents in a falling metallic body and cause deflection to the south. But they became doubtful of this explanation by the remarks of Grove, who said that "inasmuch as a falling body was



* See Gauss's criticism on Olbers, Gauss' 'Werke' Vol. V., p. 495; reference to Guglielmini's speculations in Gilbert's Ann., Vol. XII., p. 372; M. Petit's article in *Comptes Rendus*, Vol. XXXIII., p. 193, 1851, and M. Dupré's criticism of that article in Vol. XXXIV., p. 102, 1852, as well as Rosenberger's criticism of Dupré, in *Gesch. d. Physik*, Vol. III., p. 436; W. C. Redfield in *Am. Journal of Science*, Vol. III., p. 283, 1847, and the correction on p. 451 of same volume; the theoretical part, contributed by Professor Cowie, in W. W. Rundell's article, *Mechanic's Magazine*, Vol. XLVIII., p. 488.

† *Am. Journal of Science*, Vol. III., 1847, p. 139; *Report British Assoc.*, 1846, Misc. Communicat., p. 2.

moving between electrical currents, placed both north and south of its line of fall, in his opinion the effect of the one would counterbalance that of the other, so as together to produce no effect."

I myself have been considering the effect of a metallic ball falling through the varying magnetic field of the earth. Electric currents will be generated in the ball. Resolve the motion of the ball in the northern hemisphere into two components, one component, *AC*, parallel to the lines of force, the other, *CB*, perpendicular to them. The motion along *AC* produces no current in the ball. That along *CB* generates a current in a plane normal to the earth's magnetic lines of force. By Lenz's law, there is a resistance to and diminution of the motion producing the current. Hence, in all regions north of the magnetic equator there results a northerly deviation. Similar reasoning shows that south of the magnetic equator a falling metallic body experiences a southerly deviation.

Moreover, if the dip is greater in the lower levels of the atmosphere, then it will be seen from the two positions of the ball in our figure, that there is a relative motion of rotation between the ball and the earth's lines of magnetic force. The ball has in the northern hemisphere an *apparent* rotation about an axis pointing east and west, in a direction counter-clockwise when seen by an observer looking westward. Hence by Lenz's law the ball will experience a *real* rotation in a clockwise direction about the same axis. The interaction between the rotating ball and the air will cause the ball in the northern hemisphere to drift southward.

I have been unable to secure accurate data for the determination of the magnitude of the two effects, but, taking the largest rate of variation in the magnetic intensity and the dip, along a vertical line, given by Humboldt,* both effects are found much too small to cause a deviation measurable in an experiment.

It is evident that the problem of the southerly displacement of falling bodies needs reinvestigation, experimentally, and perhaps also theoretically. The Washington Monument, in

* *Cosmos*, Vol. V., pp. 97, 115, London, 1872.

our national capital, might be a good place for experimentation.

FLORIAN CAJORI.

COLORADO COLLEGE,
COLORADO SPRINGS.

ASTIGMATIC IMAGES OF THE BOTTOM OF A POOL OF WATER.

If light radiate from a point below the surface of water, it can pass out through the surface only within a circle forming the base of a right cone whose semi-angle is the critical angle.

Consider such rays lying in a vertical plane passing through the radiant point. The rays which have passed out into the air, if produced below the surface, are tangent to a virtual caustic. This caustic is a portion of the evolute of an ellipse, one cusp of which is in a vertical through the radiant point, and at a depth $\frac{d}{n}$, where d is the depth of the radiant point, and n is the index of refraction. The branches of the caustic are tangent to the surface in the circle determining the critical angle. Successive sets of consecutive rays having an increasing angle of incidence do not intersect at a common point, but they intersect at consecutive points on the caustic. If the vertical plane be rotated slightly in azimuth, the rays from the same radiant point will intersect in the caustic in its new position. This caustic from the same radiant point will always lie on a surface of revolution, formed by revolving the caustic in any vertical plane about the vertical line through the radiant point.

If the radiant point be viewed by an eye placed at a fixed point, the pupil of the eye may be conceived divided into vertical zonal elements. Rays from the radiant point in these various elements will intersect in a definite area upon the surface of revolution. The point would, therefore, appear as a hazy patch upon the caustic surface. The text-books all represent the apparent position of a coin seen through a water surface, as being lifted up and towards the eye of the observer, upon the caustic surface.

It is, however, evident that if the rays diverging from the radiant point in all azimuths, and at a fixed angle of incidence, be produced backwards after passing out into the air, they

will all intersect in a common point upon the vertical line through the radiant point. If, therefore, the pupil of the eye be divided into horizontal zonal elements, all the rays entering the eye will have a virtual intersection on this vertical line. The focus of the upper zonal elements of the eye will be slightly below those of the lower. Nevertheless, the intersection of all rays entering the eye from the radiant point will be upon a line, instead of being spread out over an area as in the other case. The fact is that a plumb line deeply piercing still water appears straight throughout. The image upon the vertical line is much more distinct than that formed upon the caustic surface. The latter image imparts a haziness to the appearance of the body viewed, but the apparent position is determined by lines which intersect in a common point, rather than by those which do not.

With this view of the matter the writer in May, 1881, presented to the Academy of Science of St. Louis a discussion of the apparent form of the flat bottom of a pool as seen through the surface.* The appearance was found to be represented by a conchoid, which was related in a simple way to the conchoid of Nicomedes. The equations of both curves were deduced, and several other cases were discussed.

In a recent number of *Annalen der Physik*,† Mattheissen has deduced the equations of these two conchoids and has pointed out that the surface produced an astigmatic effect. He likewise deduces the equation for the nebulous image due to intersection upon the caustic. The minimum of this surface and that of the conchoid are coincident and tangent to each other, and they have the water surface as a common asymptote.

FRANCIS E. NIPHER.

NOTES ON INORGANIC CHEMISTRY.

THE earliest determinations of the density of sulfur vapor were by Dumas and Mitscherlich, and gave figures which pointed to the molecule S_8 , and this has passed current until quite recent times. In 1860 Deville and Troost found

* *Trans. Acad. of Sc. of St. Louis*, Vol. IV., No. 2, p. 325.

† No. 10, 1901, S. 347.

that above 860° the sulfur molecule consists of two atoms, S_2 . More recently by boiling point and freezing point methods the molecule of sulfur in solution has been found to contain eight atoms, S_8 , and it has been inferred that the same molecule exists in sulfur vapor just above its boiling point. In the *Berichte* of the German Chemical Society, Biltz goes over the whole ground, especially examining the density of the vapor under diminished pressure at the boiling point. The greatest density he could obtain corresponded to the molecule S_7 , but this was not found to be a constant point. The conclusion he draws is that two molecules only of sulfur exist, one S_8 and the other S_2 , and that at the boiling point the molecule with eight atoms begins to decompose into molecules of two atoms. This decomposition is progressive, until at 850° it is complete, the gas at this temperature consisting wholly of the molecules S_2 .

A PATENT has recently been taken out by the Clayton Aniline Company, limited, of Manchester, for the continuous concentration of sulfuric acid, which involves the use of cast-iron vessels in the place of platinum. The dilute acid is allowed to flow in a continuous stream on to the surface of a large mass of hot concentrated acid contained in a large cast-iron pan. The concentrated acid must be of a strength not less than ninety to ninety-three per cent. From the bottom of the pan the concentrated acid is drawn off at such a rate as to keep the level of the acid in the pan constant. The great advantages claimed for the process are the simplicity and the cheapness of the plant, and it has already been shown that for most uses the acid concentrated in iron pans is satisfactory.

ABOUT a year ago an article appeared in the *Comptes Rendus* by Gautier, in which the position was taken that arsenic in minute quantities is a normal constituent of the human body. By a new and very delicate method the author found and determined quantitatively arsenic in numerous organs of the body, notably in the pancreas, brain, thymus gland and skin. Since, after digestion of the pancreas with pepsin, the arsenic remained in the nuclein residue, the existence of an arsenic-nuclein was assumed.

In the last number of the *Zeitschrift für Physiologische Chemie* there is a paper by Hödlmoser, combating Gautier in every point. In eighteen cases the pancreas and liver were examined by Gautier's method, and in fifteen other cases the same organs were examined by a method, pronounced by the author even more delicate, and in no case was any trace of arsenic found. Numerous other experiments were carried out, carefully following the work of Gautier, but always with negative results. No explanation is offered of the great discrepancy between the author's results and those of Gautier, but one is promised.

THE subject of the toxic action of boric acid is brought up anew by a description in the *Therapeutic Gazette*, by Dr. J. F. Rinehart, of two cases, occurring in his practice, of poisoning by boric acid. Each was after the administration of the acid in five-grain doses every four hours. The symptoms of poisoning appeared after several days and consisted chiefly of an erythematous eruption over the body, accompanied by extreme weakness. The patients recovered slowly on ceasing to administer the drug. The conclusion drawn by Dr. Rinehart is that "any use of boric acid as a preservative of foods should be prohibited by law, as the poisonous effect of any quantity sufficient to preserve food would appear to be proven." This conclusion would, however, seem to be somewhat overdrawn, as it is hardly probable that any such quantities of the acid as were administered in the above cases would ever be ingested from foods in which it was used as a preservative. The chief danger to be apprehended from the indiscriminate use of boric acid in foods, as was recently noticed in this column, is in the case of young children, where they are fed on milk preserved by borax. Here danger may well be apprehended. In any case food preserved by boric acid should be distinctly so labeled.

J. L. H.

CURRENT NOTES ON PHYSIOGRAPHY.

THE RIVER SYSTEM OF CONNECTICUT.

THE discovery of numerous parallel faults arranged in several systems in the small Triassic area of the Pomperaug valley in western Connecticut, and the coincidence of many

streams with lines parallel to one or another of these fault systems has led Hobbs to infer a very general dependence of stream courses on fault lines or on faulted troughs ('The River System of Connecticut,' *Journ. Geol.*, IX., 1901, 469-485). He notes that the modern school of physiographers attach 'little importance to geological structure planes as a factor in determining the position and the orientation of water courses'; and if it is joint and fault planes that are meant by 'structure planes' this comment is probably deserved as far as explicit mention of such controls is concerned. Nevertheless, the value of faulting in initiating surface inequalities, and hence in determining the course of consequent streams at the time of faulting, as well as in producing planes of structural weakness, and hence in determining the later development of subsequent streams, has not been altogether overlooked. But it is under the interaction of many controls that modern physiography finds explanation for river courses, and it is the want of consideration of other controls than faults that leaves Hobbs' paper unconvincing.

The author extends the systems of fault lines from the small Pomperaug basin all over Connecticut, preserving them rigidly straight and parallel throughout. He then compares these lines with the stream courses as shown on the topographic map of the State, and where a fair coincidence is found he concludes that there is a relation of cause and effect, thus explaining 'the definite orientation of water courses.' There are serious difficulties in the way of accepting this conclusion.

It is inherently improbable that the Pomperaug fault lines possess an extension all over the State in systems so rigid as are here postulated. Some one of the infinite varieties of curvature is much more probable than the highly specialized case of straight paths. Strict parallelism is also improbable as compared to the many possible patterns of more or less distinct divergence. The possibility of accidental coincidence between eight systems of lines, seven of which run between S. 48° W. and S. 44° E., and the river courses of a region whose slope is southerly and whose structural features (independent of faults) frequently have a similar

trend, is not given sufficient consideration. Moreover, the branchwork pattern of the Connecticut valleys has little resemblance to the network pattern of valleys that have been worn along ancient fault lines in a well-faulted area: the Stockholm district of Sweden, for example. This typical district shows a most characteristic oblique reticulation in the arrangement of its valleys, such as would be expected in a maturely dissected upland, obliquely criss-crossed by many fault lines; and it has numerous isolated lozenge-shaped uplands occupying the meshes in the network of fault-line depressions. In Connecticut the valleys have not a reticulated pattern, and the uplands as a rule are not lozenge-shaped, but give forth spurs between ramifying valleys. Well defined as is the fault-line network in the Stockholm district, its lines are neither straight nor in groups of parallels; they exhibit just such irregularities of curvature and divergence as might be expected in a geological instead of in a geometrical design.

While faulted troughs (*Graben*) might have guided many Connecticut streams for a time after the Triassic deformation, it is highly improbable that such courses could persist during the deep denudation that the region as a whole has since suffered, in the course of which many streams would presumably desert their original courses in the process of adjustment to new-found structures. While the brecciated belts of fault planes might during the denudation of the region frequently gain the patronage of subsequent streams, all other belts of weak structures would be active competitors for such patronage; yet no account is taken of such competition, although it must have been common. The northward course of the Farmington, for example, follows the weak beds of the lower Trias, and is oblique to the known faults of its district. Many of the existing streams in the lowlands have courses consequent upon the form of the glacial drift; such is the case with the Quinnipiac below Meriden; and if some of these streams have now cut down here and there to bed rock, it is only by the chance of superposition that the rock is found, as in the Connecticut above Hartford. The possibility that the lower courses of the Connecticut and Housatonic have gained their southeast trends

by superposition from a now vanished cover of Cretaceous strata is rejected because fault planes 'would, in the opinion of the writer, afford the simpler explanation.' But while simplicity is a strong recommendation in artificial mechanism, it cannot be logically employed as a means of choice between two theories of river development; if that were so, no rival could be found for the Gordian method of locating the Susquehanna and other Appalachian rivers by antecedence. Fault breccias, where they occur, may certainly exert much influence on the development of river courses in Connecticut; but until their occurrence in the central and eastern part of the State is proved by something more trustworthy than the graphic extension of systematic lines from the western part, this explanation of stream orientation may be regarded as standing in an interrogative rather than in a demonstrative attitude.

LAKE WINNIPEG.

LAKE WINNIPEG, 260 miles long, with an area of nearly 10,000 square miles or a little less than that of Lake Erie, is a member of the series of lakes that occupies an inner lowland of the ancient coastal plain, marginal to the great Laurentian highland of eastern Canada. Reports by Dowling and Tyrrell give a number of physiographic details concerning the Winnipeg basin ('Report on the Geology of the West Shores and Islands of Lake Winnipeg,' Geol. Surv. Canada, XI., 1901, F. 'Report on the east shore of Lake Winnipeg. . . .') Ibid, G.). The lake is 710 feet above sea level, with a general depth of from 40 to 60 feet. Its eastern border is relatively straight, although minutely irregular in the smaller view. The rock floor here is of Archean gneisses and granites, with a few schists, all reduced to a surface of small relief, over which post-glacial lacustrine clays have been spread to an altitude of 150 feet over the lake. The clay plain is forested, but if cleared and drained it may become 'rich agricultural land.' Further eastward, the generally even but minutely rugged Archean rises above the clays, first in isolated knobs, then in larger patches, finally occupying all the surface; it is severely glaciated, bearing little drift, but with many small lakes

in its hollows. The east shore of the lake is frequently bordered by low clay cliffs; but rocks appear in low points and islands, beyond which there are many shoals. The west shore of the lake is very irregular, a frayed outline of Cambro-Silurian strata; cross-bedded sandstones below, and even-bedded limestones (Trenton) above. These rocks frequently form bluffs, back from which the country is generally level, but rising slightly further westward. Over this upland is a mantle of boulder clay, showing faint lines of stratification as if deposited in a body of water. The boulder clay frequently assumes the form of drumlins, and many of these are noted along the lake shore and on islands, where they are cut back into cliffs, while curved beaches are strung along between them, as on the southeastern coast of Lake Ontario.

The outline of the western shore strongly suggests an effective glacial erosion, by which the Trenton border has been shaped, somewhat as has been described by Chamberlin for similar outcrops in southern Wisconsin. The similarity of Winnipeg and its fellows to Onega and Ladoga of northern Russia has often been remarked, and seems to be increased as new details are gathered.

A PIEDMONT LAKE IN BAVARIA.

WÜRM or Starnberger Lake, 15 miles southwest of Munich, is one of several water-bodies piedmont to the Alps on the upland of southern Bavaria. It has recently been monographed by W. Ule ('Der Würmseer (Starnbergersee) in Oberbayern, eine limnologische Studie.' *Wiss. Veröffentl. Ver. f. Erdkunde, Leipzig*, V., 1901, 211 p., 15 figs., 5 pl., atlas of 8 sheets). The lake has an area of 57.1 sq. kil.; an altitude of 584 met., and a maximum depth of 123 met. It lies in the Deckenschotter, or oldest glacial gravels, occupying part of a valley that was primarily the result of stream erosion between the first and second glacial epochs; but the valley has been much modified by deposits of drift from branches of the Isar glacier during the second and third glacial advances. Glacial erosion is given small value in this distal portion of the glaciated area. A slight deformation, producing a depression along the mountain base,

is thought to have had some small share in aiding the formation of a lake basin here as elsewhere along the piedmont belt; but the evidence of this is in chief part borrowed from the district of Lake Zurich, and that evidence has been somewhat discredited, as far as lake-making is concerned, in recent years. A chapter is given to the systematic relations of the lake; the element of time, or stage of development, is given too small a share in the proposed classification. Neither the interglacial valley in the Deckenschotter nor the later glacial advances are described in terms of youth, maturity or old age. Temperature, color, transparency, waves, currents, changes of level, and composition are all duly considered. The monograph as a whole is very clearly written; its chapters are closed with concise summaries, and it has current page headings and an excellent index; advantages that do not always accompany scientific publications.

W. M. DAVIS.

THERMODYNAMICS OF THE GAS-ENGINE.

THE second report of the Gas-Engine Committee of the Institution of Mechanical Engineers of Great Britain was presented on the 18th of October by Professor Burstall, of Birmingham University, and the results of experiments, preparations for which were described in the first report (*Proceedings*, 1898) were given. They involve some important details of a novel character and throw some light upon previously obscure points in the theory of that now important prime mover.

Illuminating gas was employed having a mean heating value of about 4.8 calories per liter. A new form of igniting apparatus permitted the ignition of even very weak charges with completeness and certainty, the current being obtained from four cells of the storage battery, with a low voltage and a comparatively heavy current, insuring a 'short and thick' spark.

Varying compression was adopted to determine the effect of such variation upon the efficiency of the motor, and, with each compression, varying mixtures of air and gas, changing about one per cent. at each new series of tests, supplied data for ascertaining the relative values of these mixtures.

For the first time, so far as the writer is aware, the theory of the gas-engine as here applied was constructed with the assumption of a variation of specific heats with temperature, following MM. Mallard and Le Chatelier. The following are Professor Burstall's formulas:

$$K_v = a + sT; \quad K_p = b + sT;$$

$$K_p - K_v = \text{const.} = b - a = R.$$

$$H_v = (w_1 + w_2) \int_{T_1}^{T_2} (a + sT) \delta T;$$

$$= (w_1 + w_2) [a(T_2 - T_1) + s/2 \cdot (T_2^2 - T_1^2)].$$

$$H_p = (w_1 + w_2) \int_{T_2}^{T_3} (b + sT) \delta T;$$

$$= (w_1 + w_2) [b(T_3 - T_2) + s/2 \cdot (T_3^2 - T_2^2)];$$

where H_v and H_p are the quantities of heat added during the periods of constant volume and constant pressure, respectively; w_1 and w_2 are the weight of air and gas, and the weight of residual products from the previous stroke in the clearance spaces.

The equation of the adiabatic also differs from that for constant values of specific heats, thus:

$$\delta q = K_v \left(\frac{dT}{dp} \right) \delta p + K_p \left(\frac{dT}{dv} \right) \delta v;$$

$$dT/dp = v/R; \quad dT/dv = p/R;$$

$$\delta q = K_v v/R \cdot \delta p + K_p p/R \cdot \delta v = 0.$$

$$(a + sT) v dp + (b + sT) p dv = 0.$$

$$(b - a) \log_e v + a \log_e (pv) + spv/R = \text{const.}$$

$$p^a v^b e^{spv/R} = \text{constant.}$$

The correspondence of the actual expansion lines of the indicator diagram with the adiabatic for variable specific heats was found much closer than for the usual assumption of constant values with varying temperatures. In the computations of the heat-balance the usual method would give results about fifteen per cent. lower than with variable specific heats.

The entropy equation becomes, in the latter case,

$$\phi = a \log_e \frac{T}{T_0} + R \log_e \frac{V}{V_0} + S(T - T_0);$$

where V and V_0 are the volumes at temperatures T and T_0 , respectively.

In determining the temperatures, the Callendar platinum instrument was employed; but a peculiar and ingenious special construction was adopted to secure safety of the instrument against injury by the action of the charge. Among other interesting determinations made with this thermometer, were the temperatures of the charge at various distances from the cylinder-wall. It was found that the charge was distinctly hotter at the core than adjacent to the metallic surface of the cylinder, the difference ranging from one to two hundred degrees centigrade.

The gas used required 5.49 volumes of air for combustion and produced 0.5672 volumes of CO and 1.257 volumes of steam. After combustion the volume is, total dry, 4,996. The weights were, gas, per meter, 0.6; air, 1.29. Heating values were 553 B. T. U. per cubic foot, 4,850 cal. per cubic meter.

The engine was six inches by twelve and ran at about 200 revolutions per minute and at from 90 to 100 per cent. of its rated power; usually at about 95. The compression in Series I. ranged up to from 200° C. to 300° C., and the index of the compression-curve, $pv^n = C$, from 1.28 to 1.445; its maximum being found at 311° C.; but the irregularities of the figure are too great to reveal any law. Probably 1.33 may be taken as the figure for approximate computations. The expansion-curve value of $n = 1.4$, as an average, or very nearly that, ranging from 1.328 to 1.501. The mechanical efficiency was from 68 to 80 per cent., averaging about 75.

In the final series of trials, with compression ranging from 327° C. to 452° C. as maxima, the index of the expansion-curve was about 1.3, varying from 1.2 with an exhaust temperature of 637° C. to 1.344 with a temperature of exhaust of 862° C. The compression-curve was less variable; the index averaged very nearly 1.35. The mechanical efficiency varied from 0.64 to 0.83, and the thermal efficiency from 18.1 to 22.7 per cent.

The employment of compression produced, on the whole, an increasing total efficiency with increasing terminal pressure, though reducing mechanical while augmenting thermodynamic efficiency. From 13 to 16 per cent.

of the heat-supply appeared as useful work outside the machine. The gas used ranged from an average of 24.6 cu. ft. per I.H.P. per hour to 19.7, and from 34.9 per B.H.P. to 28.5. The jacket carried away about 30 per cent. of the heat developed, the exhaust about 45 per cent. and radiation about 3. The heat-balance for the most efficient case was

I.H.P.	Jack.	Exh.	Rad.	Loss.	Total.
23.1	+ 30	+ 42.6	+ 3	+ 1.3	= 100.

R. H. THURSTON.

THE NEW STAR IN PERSEUS.

PROFESSOR W. W. CAMPBELL, director of the Lick Observatory has issued the following bulletin:

A discovery of extraordinary interest to astronomers has just been made by Professor Perrine in reference to the new star in the constellation Perseus. This star appeared suddenly and unexpectedly last February, having been discovered by Anderson in Edinburgh. In some four days its brightness increased from invisibility in ordinary telescopes until it became the brightest star in the northern sky. All available astronomical resources throughout the world were immediately devoted to the investigation of this remarkable object.

Many interesting facts concerning it have been brought to light. To mention only a few, its brightness diminished irregularly from that of the most prominent star in the northern sky in February until in June it was on the limit of visibility for trained and sensitive eyesights, where it has since remained. The star's atmosphere was violently disturbed, as shown by a study of its spectrum in the spring months and since June, at least, the spectroscope has shown that it is now a nebula, though retaining to the eye and in the telescope the point-like form of an ordinary star. The disturbance that gave rise to the new star was sufficiently violent to convert it from a dark invisible body into a gaseous nebula.

In August Professor Max Wolf, of Heidelberg, Germany, secured a four-hour exposure photograph of the region of the sky containing the new star. His negative showed the existence of some extremely faint nebulous patches

about five minutes of arc south of the star, but with no evidence of any relationship between the nebulous clouds and the star.

On September 20 Ritchey at the Yerkes Observatory photographed the same region with a more efficient instrument and found that the nebulous cloud was very nearly circular, some ten minutes of arc in diameter, but of varying intensity in its different parts with the new star situated near the middle of the nebulosity.

A recent photograph, secured by Professor Perrine with the Crossley reflector, recorded the principal features of the nebulous cloud. He compared his photograph with the Yerkes photograph of the same object and made the interesting discovery that the brightest portion of the nebula, at least, and perhaps the whole nebula, had moved to the southeast more than one minute of arc in the past six weeks.

This observation is in every respect unique. Motion on this enormous scale or one fiftieth part of this scale has never been observed for any celestial body outside the solar system, and it is morally certain that the observed phenomenon is closely related to the violent disturbances which gave birth to the new star. It is perhaps as wonderful and important as any fact yet determined in connection with new stars.

THE U. S. NAVAL OBSERVATORY.

IN his annual report to the President, Hon. John D. Long, Secretary of the Navy, indorses the recommendation of the board of visitors to the Naval Observatory, that a civilian astronomer be placed at the head of that institution. Mr. Long says:

"Attention is called to the first and very important report of the board of visitors to the Naval Observatory. I earnestly commend its recommendations to careful consideration. This board was created by act of Congress in March last. I believe its visitations will be found valuable in making the observatory efficient and in rank with the best institutions of the land. It appears that no other observatory in the world has the expenditure of so much money, but also that its results are not commensurate with those of some other observatories the expenditures of which are less. Its

head should of course be the best astronomer who has proper administrative qualifications, that can be found in the country. It is especially desirable that he should have continuity of tenure, and the observatory has undoubtedly suffered from frequent changes in its superintendents.

"While the average term of service of superintendents at Greenwich has been twenty-eight years and at Harvard fifteen, at the Naval Observatory it has been only a little over three. I urgently recommend that the legislation of the last Congress to the effect 'that the superintendent of the Naval Observatory shall be, until further legislation by Congress, a line officer of the navy of a rank not below that of captain,' be repealed, and that on the contrary it be enacted that there shall be no limitation upon the field from which the superintendent is to be selected. As well might the above-quoted statute have provided that the Commissioner of Fish and Fisheries should be selected from the line of the Marine Corps, or the Director of the Geological Survey from the line of the army.

"There is no vital relation between the navy and the observatory. It may happen that some naval officer is preeminently qualified for such a place, in which case he would be appointed to it, but the country is entitled to have unlimited range of selection. The present limitation, which shuts out the whole body of civilian astronomers and even any astronomer in the navy who does not happen to be in the line, or, if in the line, below the rank of captain, is peculiar. Only a very small proportion of naval officers are not below the rank of captain, and as most of them are required for naval services—a requirement which is now increasing—the list from which selection can be made is a noticeably small one. It is evident, too, from the wording of the above quotation from the statute, that Congress in passing it had in mind further legislation in this respect."

SCIENTIFIC NOTES AND NEWS.

THE Council of the American Association for the Advancement of Science will meet at the Quadrangle Club, adjoining the grounds of the University of Chicago, on the afternoon of Wednesday, January 1. Section H, Anthro-

pology, of the Association will also meet at Chicago during convocation week.

DR. L. O. HOWARD, chief of the Division of Entomology of the U. S. Department of Agriculture and permanent secretary of the American Association for the Advancement of Science, will give the annual lecture at the Chicago meeting of the American Society of Naturalists.

THE American Academy of Arts and Sciences has given Professor R. W. Wood, of the Johns Hopkins University, an appropriation of \$350 from the Rumford fund to aid in the continuation of his researches on the anomalous dispersion of sodium vapor. An account of the results obtained thus far will appear shortly in the *Proceedings of the Royal Society of London*.

PROFESSOR FERDINAND FREIHERR VON RICHTHOFEN, who holds the chair of geography at Berlin, has received from the German Emperor the gold medal for science for his services in supplying the German expedition to China with valuable maps.

DR. SETH LOW has resigned the presidency of the American Geographical Society, New York. He was elected to this office a year ago to succeed the late Judge Charles P. Daly.

THE regents of the State University of Iowa have granted Professor C. C. Nutting, the head of the department of zoology, leave of absence for three months, in order to enable him to join the United States Fish Commission steamer *Albatross* on its cruise to the waters of the Hawaiian Islands. Professor Nutting will have charge of the work on marine invertebrates.

MR. STEWART CULIN made a trip during the summer, on behalf of the Hon. John Wanamaker, in the interests of the Archeological Museum of the University of Pennsylvania, visiting Louisiana, New Mexico, Arizona and California. He secured some 6,000 archeological and ethnological specimens, chiefly from the southwest.

MR. YEIJI NAKAJIMA, chief engineer of the city of Tokyo, and professor in the Imperial University, with Mr. Rintaro Naoki, and Mr. Shikajiro Hattori, engineers of Tokyo, are at present in the United States studying engineer-

ing works, especially those concerned with water supply.

CAPTAIN WILLIAM CROZIER has been appointed chief of ordnance in the army with the rank of brigadier-general. Captain Crozier was formerly instructor in mathematics at West Point, and was appointed recently professor of natural and experimental philosophy to succeed General Michie, but declined the position.

ASSISTANT-SURGEON JOHN F. ANDERSON, of the United States Marine-hospital Service, has been detailed by President Roosevelt to go to Liverpool to investigate the recent outbreak there of the bubonic plague.

CAPTAIN E. L. MUNSON, assistant-surgeon U. S. A., has recently been appointed assistant professor of military hygiene in the Army Medical School in Washington, D. C.

MR. IRA A. COLLINS, recently a teacher at Ridgewood, N. J., has gone to the Philippine Islands for three years to teach for the United States Government. He will endeavor to introduce visual instruction in the schools, using lantern slides in teaching the history and geography of the United States to the natives. Mr. Collins, being also able to make plaster life masks and photographs, hopes to send some such anthropometric data to the museums of this country.

DR. WALTER HOUGH has recently returned from a five months' exploring trip in northeastern Arizona, bringing a large collection of archeological and ethnological material for the National Museum. Fifty-four or more sites were examined, and in 18 of these excavations were made, comprising the ruins lying east of Holbrook, Arizona, in the Petrified Forest Reserve; ruins on the north border of the Apache Reserve, and ruins in the Jedido Valley, Hopi Reserve.

DURING the past summer, Mr. Frank M. Chapman, the associate curator of the departments of mammalogy and ornithology, of the American Museum of Natural History, New York City, made an extended trip in the western British possessions. In Manitoba he secured material for groups of cormorants, Wilson's phalarope and the yellow-headed blackbird.

In the Selkirk Mountains he secured the specimens needed for a group of the American dipper or water-ousel.

WE trust that the announcement of the death of Dr. Arthur König, professor of physics in Berlin, published in the *New York Evening Post* and other journals, is incorrect. It seems probable that there is confusion, owing to the recent death of Dr. R. König, of Paris.

MR. THOMAS MEEHAN, the well-known horticulturist and botanist, died in Germantown on November 19. He was born in England in 1826 and came to this country at an early age. Dr. Meehan was botanist of the Pennsylvania State Board of Agriculture, vice-president and one of the curators in charge of the herbarium of the Philadelphia Academy of Natural Sciences, editor of *Meehan's Monthly*, was a fellow of the American Association for the Advancement of Science and a member of numerous other scientific societies. He was the author of valuable papers in botany and horticulture.

DR. WILLIAM FISHER NORRIS, professor of ophthalmology in the University of Pennsylvania, died in Philadelphia on November 18. He was born in that city in 1839, and graduated from the academic and medical departments of the University of Pennsylvania. Dr. Norris was well known for his researches and publications on diseases of the eye. In conjunction with Dr. C. A. Oliver he edited the standard 'System of Diseases of the Eye,' and was the author of a 'Text-book of Ophthalmology.'

DR. ALBERT LEARY GIHON, medical director of the United States Navy, retired with the rank of commodore, died from apoplexy in New York on November 17. Born in Philadelphia sixty-nine years ago, he received his education there and at Princeton College. He was made professor of chemistry and toxicology in the Philadelphia College of Medicine and Surgery in 1853, but resigned to enter the navy in 1855. He had been president of the American Academy of Medicine, of the American Public Health Association and of the Association of Military Surgeons, and was the author of contributions to naval hygiene and public health.

THE American Physiological Society will hold its fourteenth annual meeting in Chicago, on Monday and Tuesday, December 30 and 31, 1901. The sessions will be held at the Physiological Laboratory of the University of Chicago. The headquarters of the Society will be at the Hotel del Prado, 59th Street and Washington Avenue, near the University. Information regarding other local arrangements and railway rates will be furnished later. Members of the Society will please inform the Secretary at their earliest convenience whether they intend to be present and what communications they desire to make. Those who will require apparatus or other necessities for the making of demonstrations may communicate with Professor Jacques Loeb, University of Chicago.

THE steamer *Gauss*, bearing the German Antarctic Expedition, which sailed from Kiel August 11, has arrived at Cape Town.

THE New York Zoological Park has received large accessions of animals from Maine and from Hamburg. They include buffaloes, elks, bears, baboons and other animals. The gelada baboons are said to be the only specimens in captivity.

THE American Museum of Natural History, New York City, has acquired an important collection of mammals and birds from the State of Vera Cruz, Mexico, which contains good series of specimens of several species not before represented in the museum collection. The Museum has also received from the Duke of Loubat a valuable collection of mammals chiefly from the State of Jalisco, which adds much valuable material. A third collection of mammals and birds has been received from Venezuela, collected by Mr. Klages; and a final instalment of birds and mammals of the H. H. Smith collection from the Santa Marta district of Colombia has also come to hand.

THE New York *Independent* publishes an article on the Nobel Foundation by the secretary of the Swedish Nobel Committee, Dr. C. L. Lange, according to which the first distribution of the five prizes will take place on December 10, of the present year, and the amount of each prize will be about \$40,000. The amount that has been deducted from the income for local

uses is said to be one quarter of the whole amount or about \$65,000 a year.

The Journal of the American Medical Association understands that one of the wealthy families of Chicago is arranging to endow, in a most liberal manner, an institution for the study and scientific investigation of infectious diseases. The details and particulars have not yet been made public, but it is reported that it will be second in importance only to that of the gift by Mr. Rockefeller.

THE *Publishers' Weekly* gives some information in regard to the export and import of books and other printed matter for the first nine months of the present year. The value of the imports is \$2,868,489, and of the exports \$2,592,268. As compared with the same period of last year, the imports have increased about \$360,000, and the exports about \$270,000.

UNIVERSITY AND EDUCATIONAL NEWS.

As a gift of a graduate, whose name is withheld, a new building will be erected at Harvard University at a cost of nearly \$100,000. The building will contain an auditorium having a seating capacity of about 1,000.

DR. GEORGE WOODWARD has made a gift of \$20,000 for the establishment of a Woodward Fellowship in Physiological Chemistry at the University of Pennsylvania.

RECENT contributions to the Oberlin College endowment fund are: C. B. and E. A. Shield, of Chicago, \$10,000; Merritt Starr, of Chicago, \$2,500; Dr. L. C. Warner, of New York, \$3,000 from a fund now held in trust by him.

MRS. L. J. WOOD, of Jamaica Plain, Mass., has given \$1,000 to the Physical Laboratory of the Johns Hopkins University for new apparatus.

It is reported in the daily papers that a recent decision of the United States District Court of the State of Michigan greatly increases the value of the estate of William Lampson, bequeathed to Yale University. By this decision the University comes into possession of land supposed to contain large quantities of copper.

THE building at the University of Michigan devoted to physics and chemistry is being remodeled, and the alterations are now well advanced.

THE list of graduate students in Cornell University for the current year is published. It includes the names of 163 candidates for advanced degrees; of these 96 are for Ph.D., 40 for A.M., 13 for M.M.E., 11 for M.S. in Agriculture, 2 for D.Sc., and 1 for M.C.E. There are 185 graduate students in regular university courses and 15 who are not candidates for any degree. Mr. J. W. Prince (C.M.) holds the Sibley Fellowship in M.E. and Mr. L. D. Crain (Perdue) the university fellowship in the same subject. Of the 15 candidates for no degree, 2 are in M.E. Of the 185 graduates, mainly A.B.'s in the regular courses, 60 are in M.E., 68 in medicine and the remainder in various courses.

THE department of botany, of the Iowa State University, conducted its first summer school of botany at Lake Okoboji during the summer. The session continued from July 27 to August 20, and proved very successful. The summer-school laboratory was located by Professor Macbride near Okoboji post office, a central point with respect to the most diversified botanical region in the State. The work was in charge of Assistant Professor B. Shimek, and consisted chiefly of field excursions and the subsequent elaboration and laboratory investigation of the material so secured.

It is announced that Professor Robert Craik, M.D., LL.D., dean of the faculty of medicine and Stratheona professor of hygiene and public health at McGill University, will resign his position and receive a seat on the Board of Governors. Dr. Craik has been connected with McGill for over half a century.

AT the University of Toronto, Dr. Howard Barnes has been appointed assistant professor of physics.

AT the University of Michigan, Messrs. A. M. Clover, R. F. Sanford and N. F. Harriman have been appointed instructors in the chemical laboratory, and Instructor G. O. Higley has returned from a year's leave of absence in Zurich.